VOLUME 25 • NUMBER 1

March 1954

the RESEARCH Quarterly

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the RESEARCH Quarterly

of the American Association for Health,
Physical Education, and Recreation,
Department of the National Education Association,
1201 Sixteenth St., N.W., Washington 6, D. C.

Vol. 25, No. 1 MARCH 1954

CONTENTS

Athletic Achievement and the Personal and Social Adjustment of High School Boys
LOWELL G. BIDDULPH 1

A Comparative Study of Motor Fitness Tests ... HOWARD STEVEN BROWN 8

Critical Examination of Sex Education in the Elementary School ... C. LEE EGGERT 20

A Test of Softball Batting Ability ... MARGARET G. FOX and OLIVE G. YOUNG 26

Influence of Athletic Training on the Resting Cardiovascular System
FRANKLIN M. HENRY 28

Visual Movements of Batters ... ALFRED W. HUBBARD and CHARLES N. SENG 42

Teacher Needs in Health Education ... W. A. MASON, M.D. 58

Influence of Exercises, Emotional Stress, and Age on Static Neuromuscular Tremor Magnitude ... JOHN C. MITCHEM and W. W. TUTTLE 65

Changes in Minimum Certification Requirements of Physical Education Teachers in 19 States Since 1947 ... LAURENCE E. MOREHOUSE and HENRY G. MILLER 75

Relationship Between Somatotype and Motor Fitness in Women ... JOYCE A. PERBIX 84

Learning Rate of Beginning Swimmers ... M. GLADYS SCOTT 91

Relation of Breakfast Regimen to Control of Body Weight
W. W. TUTTLE, KATE DAUM, and ROSEMARY LARSEN 100

Physical Activity Experience and Interests of College Women
HELEN M. ZIMMERMAN 109

Research Abstracts ... 119

Guide to Authors ... 123

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Published in March, May, October, and December by the American Association for Health, Physical Education, and Recreation, 1201 Sixteenth Street, N.W., Washington 6, D. C. Subscription available to libraries, institutions, and departments at $5.00 per year. Of the Professional Membership ($10.00 per year), $3.00 covers subscription to the *Quarterly*. Of the Student Professional Membership ($5.00 per year), $1.50 is for subscription to the *Quarterly*. *Subscriptions to individuals through membership only.* Single copies $1.25.

Send membership dues or subscriptions to Circulation Dept., 1201 Sixteenth Street, N.W., Washington 6, D. C. Editorial Office, 1201 Sixteenth Street, N.W., Washington 6, D. C. Entered as second-class matter at the Post Office at Washington, D. C., under the act of March 3, 1879. Additional entry at Baltimore, Md.

Athletic Achievement and the Personal and Social Adjustment of High School Boys

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Abstract

In this study the personal and social adjustment of high school boys of high athletic achievement was compared with the adjustment of boys of low athletic achievement. It was found that students ranking high in athletic achievement demonstrated a significantly greater degree of personal and social adjustment than did students ranking low in athletic achievement. Because of this significant relationship it was concluded that it is important for all boys, instead of a specialized few, to develop motor ability. It is recommended, therefore, that greater emphasis be placed on intramural athletic activities rather than upon interscholastic activities which neglect the majority of boys in favor of a selected few.

IN VIEW OF THE present interest in athletics and the stress being placed upon it by our educational institutions today, the relationship of athletic achievement to personal and social adjustment takes on increased importance. A study of this relationship was undertaken by the author at the University of Utah in 1951[1] to determine if higher athletic skills are found to be associated with better social or personal adjustment in high school level male students.

A total of 461 Sophomore and Junior boys enrolled in the physical education classes at Granite and West High Schools in Salt Lake City, Utah, were used as subjects. Students in these schools were selected because they offered a cross section of boys from residential areas with diverse social and economic standards.

It seemed desirable to consider athletic achievement as represented in the typical high-school boy rather than in the trained, experienced athlete because of the varied and complex factors which seem to greatly influence the personal and social adjustment of the trained athlete, experienced as he is in competitive play. Unnatural popularity, which many athletes enjoy, is often a disintegrating influence rather than a stabilizing influence upon their personalities and is, therefore, an inaccurate gauge of their adjustment. Boys with serious handicaps were omitted in an effort to limit the study to athletic achievement as measured in a random group of typical high-school boys free from exceptional influences.

Procedure

The general procedure of the study was (1) the measurement of athletic achievement, classification, and rating of 461 high school boys to determine

[1]Thesis on file at University of Utah library. Microcard copy also available at University of Utah.

a high athletic achievement group and a low athletic achievement group, (2) the measurement of personal and social adjustment of the two comparison groups, (3) a comparison of means and standard deviations of the two comparison groups using the critical ratio technique.

It is assumed by the author that athletic achievement depends upon strength and skills, which represent menti-motor or neuro-muscular development, and endurance, which is organic development. The skills involved in athletic achievement were assumed to be speed, agility, and co-ordination. It is also assumed that athletic tests which measure achievement in these phases of development (strength, skills, endurance) are indicators of the individual's athletic achievement, and that the sums of the combined athletic achievement scores represents an individual athletic achievement index.

The following tests were used to measure the various phases of athletic achievement: 1. Full arm pull-ups on the horizontal bar; 2. The eight-pound shot-put event; 3. The standing broad jump event; 4. The 100-yard dash event; 5. The basketball throw for goal (2 min.); 6. The potato race.

In order to make allowances for differences in age, height, and weight, the California Classification Plan was used for classifying boys for measurement in the selected tests.

After total scores were calculated, participants were ranked and the 50 students having the highest scores were placed in the superior athletic achievement group, while the 50 students having the lowest scores were placed in the inferior athletic achievement group.

TABLE 1

Distribution of Scores on Athletic Achievement Tests

Scores	Frequency
431-450	1
411-430	1
391-410	6
371-390	6
351-370	16
331-350	34
311-330	44
291-310	54
271-290	73
251-270	51
231-250	57
211-230	33
191-210	28
171-190	26
151-170	15
131-150	7
111-130	5
91-110	2
71- 90	1
50- 70	

M = 265.54. S.D. = 60.158. N = 461.

To check the consistency of responses made by individuals on the athletic achievement tests, a retest was made involving a class of 19 students at West High School. The athletic tests were repeated during the week following the original testing with a correlation coefficient of .972 between first test and retest scores.

The next procedure was the comparison of the two experimental groups in adjustment. A well-adjusted individual was considered to be one in whom an integration of traits appropriate to the demands made upon him by society has taken place. Therefore, good adjustment would require a balance between self and social adjustment. In self-adjustment a feeling of personal security seems to be the dominant factor involved. It is indicative of how an individual thinks and feels about himself, his self-reliance, his sense of personal worth, his feelings of belonging, and freedom from withdrawing tendencies and nervous symptoms.[1] Social adjustment[1] is based upon feelings of

TABLE 2

Differences in Performance of a Representative Group of Superior Athletic Achievement Boys and a Group of Inferior Athletic Achievement Boys with Respect to Indices of Adjustment

Tests	High Athletic Achievement Group	Low Athletic Achievement Group	Difference	C.R. of Difference
1. California Test of Personality				
A. Self-adjustment				
Mean	61.75	55.80	5.90	2.72
Standard Deviation	10.02	11.43	1.41	
B. Social adjustment				
Mean	55.60	54.00	1.60	.76
Standard Deviation	11.09	9.64	1.44	
C. Total adjustment				
Mean	117.40	110.20	7.20	1.83
Standard Deviation	19.07	19.77	.70	
2. Intelligence quotient				
Mean	102.60	100.10	2.50	.91
Standard Deviation	12.63	14.56	1.93	
3. High-school grade point average				
Mean	1.67	1.14	.53	4.14
Standard Deviation	.57	.69	.12	
4. Teachers rating				
Mean	90.90	74.70	16.20	4.21
Standard Deviation	17.76	20.25	2.49	
5. Number of friends each Individual chooses				
Mean	14.30	13.12	1.18	1.23
Standard Deviation	3.92	4.75	.83	
6. Number of times chosen by others				
Mean	22.20	13.00	9.20	3.22
Standard Deviation	18.17	10.25	7.92	

[1]Ernest W. Tiegs, Willis W. Clark, Louis P. Thorne. *California Test of Personality.* California Test Bureau, 1942, p. 3.

social security, and is the outgrowth of a person's social skills, his knowledge of social standards, and how he functions as a social being. It also indicates his community, family, and vocational relationships, and freedom from anti-social tendencies.

The following procedures and tests were used to compare the high and low athletic achievement groups in social and emotional adjustment:

1. The California Test of Personality, Adult Series, was used to determine the extent to which the individual has developed a normal, happy, and socially effective personality. The test should also reveal any serious personality defects and should indicate the extent to which the individual has achieved a balance between self and social adjustment.

2. The most recent scores on the Henmon-Nelson Intelligence Test, Form A, 1949, were obtained as a measure of scholastic aptitude.

3. All high-school grades earned to date by the students in the two groups were obtained and grade point averages were calculated to obtain an index of scholastic achievement.

4. Four different teachers rated each student on a prepared form, which included six adjustment items with scores ranging from one to seven. Adjustment scores were determined on the following items: (a) social adjustment, (b) scholastic achievement, (c) attitude toward school, (d) general

TABLE 3

Correlations Between Athletic Achievement and Indices of Adjustment[1]

Correlation Coefficients	r	Significant[2] at 5% Level	Significant[3] at 1% Level
1. Between athletic achievement and self-adjustment	.112	Yes	Slightly Below One Per Cent Level
2. Between athletic achievement and social adjustment	.020	No	No
3. Bewteen athletic achievement and number of times chosen by others	.286	Yes	Well Above One Per Cent Level

[1]All 461 participants who took part in the original testing were used in the correlation studies.
[2]Significant at 5% level means 5 chances in 100 of the difference being strictly due to chance.
[3]Significant at the 1% level means 1 chance in 100 of the difference being strictly due to chanc.

TABLE 4

Range of Scores for Members of the Superior and Inferior Athletic Achievement Groups on Eight Indices of Adjustment

Range of:	High Athletic Achievement Group	Low Athletic Achievement Group
1. Self-adjustment Scores	34.00 to 83.00	19.00 to 77.00
2. Social adjustment scores	25.00 to 82.00	24.00 to 73.00
3. Total adjustment scores	59.00 to 165.00	59.00 to 144.00
4. Intelligence quotient scores	75.00 to 136.00	67.00 to 139.00
5. Grade point averages	.17 to 2.83	.11 to 3.00
6. Teachers ratings	55.00 to 140.00	45.00 to 123.00
7. Number of friends each chose	7.00 to 23.00	3.00 to 24.00
8. Number of times chosen by others	3.00 to 80.00	0.00 to 40.00

appearance, (e) grooming, and (f) checking of positive and negative traits which best describe the student.

5. A sociogram was administered to 461 students who took the athletic achievement tests to determine whether the well-adjusted individuals were chosen more frequently by their associates in work, play, and social situations, and whether they listed a greater number of associates as friends. In this survey, the student was asked to list the names of his good friends and people he would like for friends. He was also asked to list the names of five members of his physical education classes he would like to (1) work on a committee with, (2) go on an overnight fishing trip with, (3) invite to a birthday party, and (4) play on a basketball team with.

Findings

Means and standard deviations were determined for the eight indices of adjustment previously mentioned for both the high and low athletic achievement groups. These means were compared statistically by using critical ratio techniques to test the significance of differences. The following results were observed:

1. The superior athletic achievement group showed a higher mean self-adjustment score on the California Test of Personality. There was a difference between the means of 5.90 with a critical ratio of 2.72 which is statistically significant at the 1-per-cent level.

2. Although the superior athletic achievement group did not show a significantly higher mean score on the social adjustment scale of the California Test of Personality, this group did show a significantly higher mean on two other social adjustment indices—that is, teachers' ratings and sociograms.

3. The high athletic achievement group showed superior achievement in school as measured by grade point averages. They achieved a higher mean grade point average (difference between means significant at the one per cent level) with a smaller standard deviation. The low athletic achievement group displayed a much wider range of scores than did the high athletic achievement group.

4. Although the grade point averages are significantly higher for the superior athletic achievement group, this superiority cannot be explained in terms of differences in intelligence. The mean intelligence quotient for the high athletic achievement group was but 2.5 points higher than the mean intelligence quotient for the low athletic achievement group. This is an insignificant difference, and scholastic ability as measured by intelligence tests can be considered equal for both groups. The low athletic achievement group, however, had a wider range of scores and a greater standard deviation.

5. Members of the superior athletic achievement group were rated considerably higher on items of adjustment by their respective teachers. The difference in ratings between the two groups is statistically significant at the 1-per-cent level.

6. Members of the superior athletic achievement group listed more personal friends, and were chosen more frequently by associates in work, play, and social situations. Greater popularity is evidenced by a difference in means of 9.2 for the number of times chosen by others, which is significant at the 1-per-cent level.

In summary, these results clearly indicate that the group ranking high in athletic achievement demonstrated a significantly greater degree of personal and social adjustment than did the group ranking low in athletic achievement. The conclusion seems to indicate that the ability to control the nerve-muscle mechanisms of the body in acts of skill fosters the growth of an individuals' sense of personal worth, self-reliance, personal freedom, and increases his worth as a social being. Likewise, satisfactory adjustment involving a sense of personal worth, and responsibility as a social being increases the individual's ability in menti-motor or neuro-muscular development.

The findings of this investigation seem to indicate an interacting relationship between athletic achievement and adjustment. Consequently, it may be concluded that, other things being equal, the individual who has developed a high degree of motor skill will be better equipped to meet the problems of personal and social adjustment than will the individual who is frustrated in the motor control of his body.

Conclusions and Recommendations

1. It must be concluded from this study that athletic achievement is a much more important factor in personal and social adjustment than we have been led to believe.

(a) Because of the significant relationship between athletic achievement and personal and social adjustment as indicated, it becomes important for all boys, instead of a specialized few, to develop motor ability. It is recommended, therefore, that the major emphasis of a physical education program for boys be upon intramural athletic activities, which benefit many individuals, rather than upon interscholastic activities which neglect the majority of boys in favor of a selected few.

(b) It is also recommended that athletic activities be emphasized for their inherent value by placing emphasis upon participation as a player rather than upon participation as a spectator.

2. It is concluded that boys with low athletic achievement should be identified and their adjustment problems investigated so that appropriate help may be given.

(a) It is recommended that boys possessing low athletic achievement be recognized in early life, or during their formative years, so they may be helped to "hold up their heads" among their peers.

(b) It is also recommended that teachers be made aware of the relationships of athletic achievement to personal and social adjustment, and that they be prepared to make adequate tests of athletic achievement on the various grade levels.

(c) Boys with low motor ability need to be better understood in the home. It is recommended, therefore, that parents also be informed of the relationship of athletic achievement to adjustment and taught to recognize the adjustment problems that may be associated with a lack of motor skill.

(d) Because of the apparent relationship between athletic achievement and adjustment, as measured by devices used in this investigation, there is a need to study this relationship using other adjustment-type tests. It is recommended, therefore, that additional study be made of this relationship using projective-type tests to measure adjustment.

(Submitted 2-25-52)

A Comparative Study of Motor Fitness Tests

HOWARD STEVEN BROWN
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Abstract

Four criteria were used in this study in determining which of 12 test batteries were superior. The two validating criteria used were: the correlation coefficients obtained from the test batteries and a *criterion score* that was derived from 26 test elements which had been administered to 208 subjects; and the critical ratios obained from groups recognized as differing in motor fitness. The other two criteria were *administrative feasibility* and *suitability to the students.* The best measure of motor fitness was the General Motor Ability Score while the Indiana University Motor Fitness Index ranked second, when evaluated in the light of these criteria.

THE PURPOSE of this investigation[1] was to determine the validity of the Southern Methodist University Motor Fitness Test Batteries[2] as compared with selected motor test batteries. Then on the basis of the findings and in the light of their administrative feasibility and suitability to the needs of college men, recommendations were to be made as to which battery should be used.

Procedure

Terminology. The initial step was to clarify the meaning of the terms *physical fitness* and *motor fitness.* In the past the terms have been used to express many concepts of human welfare and fitness (1-13). The present trend seems to be to use *physical fitness* when referring to the general fitness of the various systems of the body while *motor fitness* has taken on a rather specific muscular connotation. In this investigation, *motor fitness* was used when referring to test batteries that were primarily concerned with the measurement of big muscular performances.

Test Batteries. The selection of test batteries and test elements was carried on simultaneously. The batteries used for comparison in the investigation were: Southern Methodist University Motor Fitness Test—three- and five-event batteries, Strength Index, Physical Fitness Index, Larson's Outdoor Test—Forms A and B,[3] General Motor Capacity Score, Motor Quotient, Gen-

[1]This study was made in partial fulfilment of the requirements for the degree of Doctor of Physical Education, Indiana University, 1952.

[2]The three-event battery was composed of: sit-ups for two minutes, 240-yard shuttle run, and pull-ups. The five event battery was composed of: sit-ups for two minutes, push-ups, squat thrusts for one minute, 240-yard shuttle run, and pull-ups.

[3]In Form A the scores were computed from the scales developed by the author of the test, while in Form B the scales were developed from the scores made in this investigation. It was deemed desirable to use the two forms because in administering a few of the elements the procedure recommended by the author was not followed in every detail.

eral Motor Achievement Score, General Motor Achievement Quotient, Larson's Dynamic Strength Index, Indiana University Motor Fitness Index—Forms A and B[3], and Brown's Test.[4]

Validating Criteria. The establishment of the first of two validating criteria to be used in comparing the test batteries posed the problem of selecting factors basic to motor performance and choosing test elements that would effectively measure them. A tabulation was made of the factors isolated in 26 factor-analysis studies, as shown in Table 1 (14-38). On the basis of the frequency of isolation the leading factors were determined. From this list, by a process of logical analysis, the following factors were selected for use in this investigation: strength, speed or velocity, motor control, motor educability, endurance, balance, dead weight, and body size.

To get the test elements that would best measure the selected factors, the elements used in 66 studies were tabulated and from them a selection was made on the following bases: frequency of use, reliability, and administrative feasibility. In addition, a few test elements needed to complete a few of the selected test batteries were included. The selected motor factors and criterion test elements plus range of reliabilities in past studies and that found in this investigation are shown in Table 2.

Initially it was planned that the average T-scores which were derived from the summation of the T-scores made on each of the 28 selected test elements should serve as one of the evaluating criteria. In the course of the investigation it was found that two of the elements—drop-off and simplified pulse ratio—failed to correlate at the 2-per-cent level of confidence with the criterion battery scores. It was also found that the full battery of 28 elements failed to discriminate as accurately between groups having a significant difference in motor ability as did a battery minus the two elements just mentioned; therefore the *final criterion* was composed of the average T-scores made on 26 test elements.

The second validating criterion was the critical ratios between the scores made by three groups believed to be significantly different in their motor fitness. These groups were selected as follows: the superior fit were the Freshman athletes; the medium fit were the five best non-athletes in each of ten class students, while the poorest fit were the five weakest students in each of the ten sections. The last two groups were selected by the subjective ratings of their instructors.

Feasibility and Suitability. The other factors considered in the final evaluation of the test batteries were their administrative feasibility and suitability to the students' needs. In comparing the test batteries as to administrative feasibility, their rank orders in the following were averaged: time cost of actually administering the battery, extra administrative assistance needed, extra time

---

[4]This is an unpublished test composed of: the 240-yard shuttle run, pull-ups, and the turn jump—measure of degrees an individual can turn on one jump.

TABLE 1

Tabulation of Factors and Their Order of Isolation in 26 Factor Analysis Studies

Authors of studies, dates studies published, and order of factor isolation

Isolated factors	McCloy, C. H. 1934	McCloy, Emma 1935	Coleman, J. W. 1937	Rarick, L. 1937	Harris, J. E. 1937	Wendler, A. J. 1938	Hutto, L. E. 1938	Carpenter, A. 1938	Metheny, E. 1938	Roulhac, C. M. 1940	Coleman, A. J. 1940	Carpenter, A. 1940	Larson, L. A. 1940	Carpenter, A. 1941	Carpenter, A. 1941	Larson, L. A. 1941	Larson, L. A. 1941	Cureton, T. K. 1942	Seashore, H. G. 1942	Hall, D. M. 1942	Carpenter, A. 1943	Latham, D. E. 1945	Schafer-Jones 1947	Cureton, T. K. 1947	Phillips, M. 1949	McCraw, L. W. 1949	Frequency of isolation	Rank order of factors
Abdominal strength																											2	15.5
Agility				4			5									4		2				4			2		2	15.5
Arm strength																											2	15.5
Athletic ability																										2	1	
Balance or postural steadiness																			3		2	3					3	9.5
Basal metabolic rate																								2			1	
Big muscle coordination	3									2						3							1	6	6	1	6	4.5
Body size and age																				3			2	1	1		3	9.5
Body type																											1	
Cardiovascular condition																								1			1	
Dead weight		3	3	5	3		2				4			3			1							5			7	3.0
Dynamic gross motor ability																											1	
Dynamic object control w/implement																										7	1	
Dynamic object control w/o implement																										5	1	
Dynamic strength													1			1	2	2	4								5	
Endurance										4												1					2	15.5
Fine motor abilities																		1	1			6					1	
Flexibility				3			4				3																2	15.5
Height or structure						3			3			2				3					3						3	9.5
Motor educability				6																						3	6	4.5
Muscle latency																				2							1	
Physical development																											1	
Physical fitness performance																										4	1	
Power										3						4						5					3	9.5
Sensori-motor control						4								3												8	3	9.5
Speed			2						1	1			2			2											3	9.5
Static strength																											2	15.5
Strength	1	1	1	1	2	1	1	1	2		1	1		1	1			3		1	1	2		4	1		18	1.0
Susceptibility to disease																											1	
Thinness in fat																							3				1	
Velocity	2	2		2	1	2	3				2		2	2							4				3		10	2.0
Unidentified							6												4		4				4		5	

TABLE 2

Selected Motor Factors and Criterion Test Elements Plus Range of Reliabilities in Past Studies and That Found in This Investigation

Factor criterion test elements	Range of reliability as reported in selected studies r low	high	Reliability as found in this investigation r	S.E.
Strength				
Arm strength		— .91		
Back strength	.62	— .97	.855	+ .022
Dips (parallel bars)	.81	— .95	.936	+ .012
Grip, right	.54	— .95	.802	+ .030
Grip, left	.46	— .95	.740	+ .037
Leg strength	.69	— .96	.884	+ .021
Pull-ups or chins	.86	— .99	.915	+ .015
Push-ups		— .93	.903	+ .017
Velocity or speed				
Running high jump	.74	— .96	.886	+ .024
60-yard dash	.84	— .97	.823	+ .031
60-yard shuttle run			.819	+ .036
Standing broad jump	.66	— .98	.905	+ .018
Vertical jump[1]	.61	— .98	.920	+ .107
Motor control				
Bar snap	.92	— .93	.863	+ .022
Dodge run[1]	.68	— .97	.875	+ .026
Football punt	.82	— .86	.803	+ .033
Softball throw (dist.)	.89	— .97	.916	+ .016
Squat thrust (10 sec.)	.72	— .92	.809	+ .031
12-pound shot put	.80	— .97	.875	+ .026
Turn jump			.649	+ .053
Motor educability				
Iowa-Brace		— .61	.801	+ .037
Endurance				
Sit-ups (2 min.)	.71	— .99	.823	+ .030
Squat thrust (60 sec.)	.70	— .97	.839	+ .027
240-yard shuttle run			.840	+ .026
Drop-off (240-yd. shuttle run + 60-yd. shuttle)[2]				
Pulse-ratio (simplified)[2]	.53	— .90	.851	+ .030
Balance				
Stepping-stone test	.59	— .95	.813	+ .031
Body size				
Lung capacity	.82	— .96	.949	+ .010

[1]Administration slightly different from that in previous studies.
[2]Test elements not used in computing the final criterion.

needed to put up and take down the equipment, and consideration of the weather factor—whether the battery could be administered indoors.

In determining their suitability to the needs of the students, the test batteries were rank ordered in the light of the following factors: motivation for fitness, the physical strain on the participants, and the reaction of the students to the testing program and physical education in general.

Collecting of Data. The test batteries and the criteria for evaluating them having been selected, the next step was to collect the data. All 28 test elements

were administered to 208 of the members of ten Freshman physical education class sections. The T-scores were computed for the individual test elements and test batteries. The intercorrelations of test elements with the initial and final criterion and the test batteries with the initial and final criterion were then computed as shown in Tables 3 and 4.

On the basis of correlations with the final criterion, the test batteries were given a rank order as to validity. The critical ratios were then computed for the three groups believed to differ in motor fitness and a second ranking of test batteries for validity was made on this basis. The rank orders as obtained from each of the two techniques of determining validity along with those obtained from administrative feasibility and suitability to students' needs were then averaged for the final rank order which was used as the basis for the final evaluation of the test batteries.

Analysis of Data

A study of the intercorrelations carried in Table 3 reveals that as a whole the intercorrelations between the test elements were rather low; thus, it appears that in general the selected elements were not measuring the same thing. On the other hand, the correlations between the final criterion and the test batteries as shown in Table 4 reveal that as a whole the selected batteries were fairly good measures of motor performance.

As shown in Table 4, the correlation coefficients of the five best test batteries with the *final criterion* fell within a very narrow range. Neither of the Southern Methodist University batteries was in this group, although the correlation coefficient of .797 for the five-event battery was high enough for it to be acceptable as a good measure of motor fitness.

The second validating criterion, critical ratios, revealed that the scores made by the athletes and best non-athletes on all of the test batteries were superior to those made by the poorest non-athletes at the 1-per-cent level of confidence, as shown in Table 5. On the other hand, a number of test batteries failed to differentiate at this high level between the athletes and the best non-athletes, although the critical ratios obtained from the *final criterion* scores indicated at the 1-per-cent level of confidence that the athletes were superior. It should be noted that the five-event battery of the Southern Methodist University Test differentiated between the athletes and the best non-athletes at the 1-per-cent level of confidence while the three-event battery failed to differentiate at the 5-per-cent level.

As shown in Table 6, the Southern Methodist University three event battery ranked first as to administrative feasibility and next to last as to suitability to the students' needs, while the five-event battery ranked fifth as to administrative feasibility and last as to suitability to the students' needs.

According to the summation of the rank orders of the four criteria used in this investigation and as shown in Table 6, the General Motor Ability Score was the best of all test batteries compared. The second best battery was the Indiana University Motor Fitness Index—Form A. The third and fourth

TABLE 3

The Intercorrelations of the Twenty-eight Test Elements with the Initial and Final Criterion

Code number and name of element	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	45	47
4. Sit-up	.425	.431	.276	.319	.448	.328	.195	.222	.247	.199	.285	.045	.350	.281	.171	.189	.391	.415	.358	.270	.352	.287	.119	.291	.391	.165	.148	.501	.479
5. 240-yard shuttle		.398	.317	.233	.363	.357	.149	.158	.254	.200	.415	.048	.503	.426	.212	.285	.391	.440	.355	.293	.546	.568	.370	.429	.334	.195	.389	.605	.576
6. Chins			.477	.156	.467	.261	.169	.107	.221	.191	.354	.040	.346	.374	.067	.245	.587	.705	.332	.285	.391	.383	−.012	.368	.367	.093	.281	.547	.536
7. Bar snap				.265	.339	.203	.193	.197	.353	.297	.363	.092	.360	.457	.243	.369	.438	.474	.366	.353	.369	.425	−.067	.410	.344	.100	.324	.565	.585
8. Squat-thrust (10-sec.)					.315	.496	.240	.163	.190	.139	.251	.108	.251	.258	.152	.186	.202	.203	.244	.154	.217	.186	.061	.211	.374	.019	.290	.469	.444
9. Push-ups (floor)						.470	.155	.209	.222	.221	.162	.001	.306	.236	.049	.128	.578	.499	.218	.152	.335	.289	.033	.144	.301	.004	.142	.492	.475
10. Squat-thrust (60-sec.)							.275	.219	.250	.227	.240	.101	.263	.257	.184	.227	.317	.297	.355	.210	.292	.347	−.017	.301	.385	.083	.286	.549	.513
11. Right grip								.619	.477	.537	.240	.348	.095	.285	.172	.038	.220	.286	.211	.322	.235	.267	−.137	.193	.481	−.088	.108	.427	.443
12. Left grip									.554	.577	.162	.342	.079	.189	.064	.069	.247	.250	.174	.201	.194	.181	−.012	.105	.404	.009	−.001	.374	.417
13. Leg strength										.615	.231	.298	.243	.369	.195	.244	.314	.401	.355	.415	.196	.237	−.046	.341	.525	.063	.130	.540	.550
14. Back strength											.237	.271	.211	.291	.081	.124	.340	.362	.359	.410	.233	.266	−.052	.238	.533	.017	.162	.505	.528
15. Vertical jump												.206	.414	.613	.320	.318	.332	.392	.420	.393	.421	.450	−.059	.518	.459	.076	.299	.558	.587
16. Lung capacity													.123	.277	.087	.012	.088	.200	.116	.152	.039	.053	.010	.214	.357	−.075	.056	.270	.288
17. Dodge run														.521	.087	.431	.380	.406	.465	.358	.505	.494	−.028	.458	.403	.079	.417	.580	.601
18. Standing broad jump															.299	.361	.407	.497	.448	.426	.457	.479	−.116	.619	.499	.083	.458	.659	.694
19. Turn jump																.261	.118	.147	.170	.181	.254	.249	−.156	.350	.272	.022	.152	.326	.349
20. Balance test																	.288	.310	.392	.298	.341	.383	−.114	.397	.308	.051	.322	.442	.455
21. Dips (parallel bars)																		.832	.370	.287	.425	.407	−.016	.289	.434	.023	.273	.611	.613
22. Arm strength (Rogers' formula)																			.412	.344	.451	.433	−.030	.409	.513	.088	.279	.675	.679
23. Softball throw for distance																				.610	.461	.386	−.079	.494	.621	.026	.336	.619	.624
24. Football punt for distance																					.407	.433	−.109	.534	.536	.106	.292	.573	.564
25. 60-yard dash																						.586	−.049	.488	.466	.165	.331	.637	.614
26. 60-yard shuttle																							−.385	.512	.424	.099	.426	.610	.653
27. Drop-off*																								−.115	−.105	.137	−.043	−.012	−.115
28. Running high jump																									.488	.182	.482	.651	.653
29. 12-pound shot put																										.008	.292	.707	.726
30. Pulse ratio (simplified)																											.035	.233	.142
31. Iowa-Brace																												.502	.493
45. Initial criterion																													.933
47. Final criterion																													

*Time on 240-yard run divided by time on 60-yard shuttle.

TABLE 4

Intercorrelations Between Test Batteries and Initial and Final Criterion Computed from Scatter Diagrams

Code number and test battery	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
32. SMU—3 events	.889	.598	.610	.732	.401.	511	.536	.432	.728	.742	.829	.652	.779	.746	.749
33. SMU—5 events		.595	.581	.697	.412	.527	.554	.427	.681	.755	.774	.684	.804	.705	.787
34. S.I.			.594	.662	.580	.361	.781	.644	.644	.646	.573	.635	.812	.680	.835
35. P.F.I.				.588	.199	.471	.305	.278	.638	.603	.614	.550	.575	.632	.597
36. Larson's Outdoor Test—Form A					.503	.593	.693	.523	.775	.771	.734	.713	.812	.964	.807
37. GMCS						.743	.724	.283	.673	.645	.452	.696	.714	.535	.726
38. MQ							.429	.075	.780	.715	.570	.719	.650	.594	.659
39. GMAS								.790	.652	.627	.594	.665	.833	.679	.841
40. GMAQ									.397	.408	.452	.409	.587	.545	.624
41. Dynamic Strength Index										.933.	.737	.940	.787	.806	.794
42. IU Motor Fitness Index Form A											.645	.963	.796	.796	.803
43. Brown's Test												.617	.807	.740	.778
44. IU Motor Fitness Index Form B													.768	.765	.783
45. Initial Criterion														.833	.983
46. Larson's Outdoor Test—Form B															.832
47. Final Criterion															

TABLE 5

Critical Ratios Between the Scores Made by Groups of Varying Motor Fitness on the Sixteen Test Batteries

Coded event number test battery		Critical ratios		
		Between athletes and best non-athletes	Between best non-athletes and poorest non-athletes	Between athletes and all non-athletes
32.	SMU (3 events)	1.76	6.15	7.52
33.	SMU (5 events)	2.93	6.94	7.75
34.	Strength Index	2.85	7.59	6.91
35.	PFI	1.13	6.94	2.71
36.	Larson's Outdoor Test—Form A	2.30	9.22	5.38
37.	GMCS	2.57	5.80	6.55
38.	Motor Quotient	.57	6.28	5.22
39.	GMAS	5.04	7.37	9.51
40.	GMAQ	4.05	4.93	7.31
41.	Dynamic Strength Index	1.71	9.99	7.10
42.	IPMFI—Form A	2.27	6.33	6.29
43.	Brown's Test	.81	9.82	5.85
44.	IUMFI—Form B	2.12	8.01	6.29
45.	Initial criterion	4.20	10.12	12.00
46.	Larson's Outdoor Test—Form B	2.58	9.17	10.18
47.	Final criterion	4.70	9.85	12.10

TABLE 6

Rank Order of Test Batteries According to the Criteria of Validity, Feasibility, and Suitability

Test batteries	Validity		Administrative feasibility	Suitability to Students	Summation of ranks	Final rank order
	r with final criterion	Critical ratios				
SMU (3 events)	10	10	1.0	13	34.0	11.0
SMU (5 events)	6	3	5.0	14	28.0	7.0
Strength Index	2	4	12.0	6	24.0	4.0
PFI	14	12	13.5	6	45.5	14.0
Larson's Outdoor Test—Form A	4	7	9.5	6	26.5	6.0
GMCS	11	6	7.0	6	30.0	8.5
Motor Quotient	12	14	8.0	6	40.0	13.0
GMAS	1	1	11.0	6	19.0	1.0
GMAQ	13	2	13.5	6	33.0	10.0
Dynamic Strength Index	7	11	6.0	6	30.0	8.5
IUMFI—Form A	5	8	3.0	6	22.0	2.0
Brown's Test	9	13	3.0	12	37.0	12.0
IUMFI—Form B	8	9	3.0	6	26.0	5.0
Larson's Outdoor Test—Form B	3	5	9.5	6	23.5	3.0

ranking batteries were: Larson's Outdoor Test—Form B and the Strength Index. The Southern Methodist University five-event battery ranked seventh, while the three-event battery ranked 11th.

On the basis of the above findings, it appeared that neither of the Southern Methodist University test batteries received high enough ratings to warrant their continued use. It was recommended that either the General Motor Ability Score or the Indiana University Motor Fitness Index—Form A be used.

Summary and Concusions

The purpose of this investigation was to determine the comparative validity of the Southern Methodist University Motor Test Batteries with that of other batteries used to measure motor fitness. Then, on the basis of the findings and in the light of other criteria of administrative feasibility and suitability to the students' needs, they were to be accepted or rejected. In case of the latter, another test battery was to be recommended to take the place of the one in use.

Two measures of validity were used. The first was that of the correlation coefficients between the various test vatteries and the *final criterion.* The five best test batteries and their correlation coefficients along with the standard error were: General Motor Ability Score, .841±.020; Strength Index, .835± .021; Larson's Outdoor Test—Form A, .807±.024; and the Indiana University Motor Fitness Index—Form A, .803±.025.

A second group of test batteries having correlation coefficients almost as high and within the range of acceptability were: The Dynamic Strength Test, .794±.026; Southern Methodist University Test (5 events), .787±.026; Indiana University Motor Fitness Index—Form B, .783±.027; Brown's Test, .778±.027; and Southern Methodist University Test (3 events), .749±.030.

The remainder of the test batteries whose correlation coefficients were so low that according to this criterion they could not be considered as good measures of motor fitness were: General Motor Capacity Score, .726±.033; Motor Quotient, .659±.039; General Motor Achievement Quotient, .624± .042; and the Physical Fitness Index, .597±.044.

It should be noted that a number of the test elements correlated very high with the *final criterion;* the two highest being the 12-pound shot put, .726± .033 and the standing broad jump, .694±.036.

The second criterion for determining validity of the test batteries was the critical ratios obtained from the mean scores of groups of subjects recognized as having reached different levels of motor fitness. The test batteries that were best and could be depended upon to differentiate between the athletes and the best non-athletes at the 1-per-cent level of confidence were five in number. The batteries and their critical ratios were: General Motor Ability Score, 5.04; General Motor Achievement Quotient, 4.05; Southern Methodist University Test (5 events), 2.93; Strength Index, 2.85; and Larson's Outdoor Test—Form B, 2.58.

A second group of test batteries whose critical ratios were significant at the 5-per-cent level were: General Motor Capacity Score, 2.57; Larson's Outdoor Test—Form A, 2:30; Indiana University Motor Fitness Index—Form A, 2.27; and Indiana University Motor Fitness Index—Form B, 2.12. The remaining test batteries that failed to differentiate between the athletes and best non-athletes at the 5-per-cent level of confidence were: Southern Methodist University Test (3 events), 1.76; Larson's Dynamic Strength Index, 1.71; Physical Fitness Index, 1.13; Brown's Test, .81; and Motor Quotient, .57.

In the light of the criterion of administrative feasibility, the most desirable test battery was the Southern Methodist University Test (3 events). The next three which were considered equally good were the Indiana University Motor Fitness Index—Forms A and B, and Brown's Test. A group only slightly less desirable was: Southern Methodist University Test (5 events), Dynamic Strength Index, General Motor Capacity Score, and Motor Quotient. The remaining test batteries were ranked in the following order: Larson's Outdoor Tests—Forms A and B, General Motor Ability Score, Strength Index, Physical Fitness Index, and General Motor Achievement Quotient.

In the light of the criterion of suitability to the student's needs, 11 of the batteries were given an equal rank for first place. The three batteries that failed to measure up were: Brown's Test and the Southern Methodist University Tests (3 and 5 events).

On the basis of the average of the rank orders obtained from the four listed criteria, the test batteries were given the following ranking as predictors of motor fitness: (1) General Motor Ability Score; (2) Indiana University Motor Fitness Index—Form A; (3) Larson's Outdoor Test—Form B; (4) Strength Index; (5) Indiana University Motor Fitness Index—Form B; (6) Larson's Outdoor Test—Form A; (7) Southern Methodist University Test (5 events); (8.5) Dynamic Strength Index and General Motor Capacity Score; (9) General Motor Achievement Quotient; (10) Southern Methodist University Test (3 events); (11) Brown's Test: (12) Motor Quotient; (13) Physical Fitness Index.

When compared with the other test batteries, the Southern Methodist University batteries—three and five events—ranked 11th and 7th respectively. In the light of these findings, it seemed that a substitute battery should be adopted. It was recommended that either the General Motor Ability Score or the Indiana University Motor Fitness Index—Form A be adopted.

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(Submitted 6-25-53)

Critical Examination of Sex Education in the Elementary School

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Abstract

This study presents the position of educational and religious leaders, as well as that of biology, physiology, psychology, and sociology on sex education in the elementary school. The study reviews what authorities in these fields consider to be the school's function and responsibility. Findings indicate that family life education, of which sex education is a part, should be integrated into the school program at all levels. It points to the school administrators and lack of trained teachers as the chief bottlenecks to family life education in the public schools. Work in family life education, the study concludes, should be spearheaded jointly in the school and community by the Parent Teacher Association and the school staff. The study emphasizes a need for adequate pre- and in-service teacher training and adequate teaching aids.

IT WAS ESTIMATED that in 1948 not more than 5 per cent[1] of the 141,300[2] public elementary schools in the United States had effective sex education programs. Within this 5 per cent, difference of opinion existed regarding what a good sex education program was and how it functioned. State departments, with 45 of 48 departments responding,[3] agreed almost unanimously that sex education was needed in the elementary schools. However, they appeared to lack an understanding of when sex education should start, what it should include, and how it should be implemented.

In the light of these conditions, there appeared to be need for an extensive study of family life and more specifically of sex education in the elementary school. It was with this evidence and the desire upon the part of the writer to get answers helpful in raising his own family that the following four-year study was undertaken.

Procedure

The following steps were followed in the completion of this study:

1. Research studies relating to sex education in the elementary school were examined.

2. The fields of biology, physiology, psychology, and sociology were reviewed to discover the opinions of authorities in these fields regarding sex education in the elementary school.

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[1]J. A. Goldberg, Sex Education or Social Hygiene Education in Schools of Forty Cities, *Journal of Social Hygiene*, 33: 437, Dec. 1947.

[2]The Council of State Governments, *The 48 State School Systems*, p. 194.

[3]From the results of letter questionnaire sent by the writer to the 48 state departments of education, 43 out of 45 responses expressed the opinion that sex education is a responsibility of the public school.

3. The points of view of authorities in the field of education were examined relative to sex education in the elementary school.

4. The various family life and mental hygiene associations throughout the United States were contacted and their materials on sex education were studied.

5. State departments of education were contacted to obtain their views on sex education in the elementary school. They were asked to name schools in their respective areas which were carrying on effective sex education programs. Materials from these sources were collected and carefully examined.

6. In light of the accumulated evidence, the recommendations were made regarding sex education in the elementary school.

Findings

Some of the significant findings from the study are as follows:

1. Authorities in the fields of biology, physiology, phychology, and sociology felt that sex education should be a part of a well balanced elementary school program.

2. Authorities in the fields of family life education and mental hygiene agreed that sex education should be carried on by the schools. They concluded that the building of socially acceptable attitudes in boys and girls is an important part of sex education and of elementary education generally.

3. Authorities in the field of education agreed that (a) sex education should be a continuous process starting the day a child is born, and continuing throughout a child's school life; and (b) sex education should be integrated into the school program and given whenever occasions arise within all phases of the elementary school.

4. Since less than 5 per cent of a cross section sample of elementary schools in the United States included sex education in their curricula, it may be concluded that the public elementary schools are failing generally to meet the sex education needs of boys and girls.

5. Ninety-three per cent of the state superintendents of public instruction responding to a questionnaire indicated that they feel a need for and would support a well-planned sex education program as part of the elementary school program.

6. Research points to the fact that sex education leads to greater marital happiness. Parents should be supplied with this research information, together with the ways in which it was gained.

7. Church groups favor sex education of one kind or another. They differ chiefly on method, materials, and personnel to carry on the program. The school is the one common community denominator which, with vision, can diplomatically draw these community groups together for purposes of developing and promoting an effective sex education program for boys and girls.

8. Parents, by their behavior in the home, by their attitudes, and by their

responses or lack of responses, are continually giving either good or bad sex education to their children.

9. Parents appear desirous of becoming increasingly effective in the sex education (and in the broad sense family life education) of their children, especially when they understand the aims of a sex education program and when they have a part in the planning of the program.

10. Many elementary schools are studying problems relating to sex and family life education and are beginning to develop programs to meet local community needs.

11. The elementary school must recognize that desirable and undesirable sex attitudes are formed early in life. It must, therefore, plan group representations to cover the broad areas of family living and in addition, analyze each child's needs individually (based on his questions, his observations, his comments, his play habits, and his general attitudes) and plan a program which will be most beneficial to that child.

Conclusions

Conclusions drawn from these findings are as follows:

1. Since the Parent Teacher Association is the strongest existing link between school and community, every effort should be made to strengthen the effectiveness of this organization.

2. The teacher must be careful not to "overdo," thus forcing sex education on children. However, when an intelligent question is asked, a child has the right to expect an honest, intelligent response.

3. Adequate recreational facilities are one of the cheapest and most effective means a community has of directing youth activities into wholesome channels.

4. There cannot be a high degree of standardization of sex education programs in elementary schools, since the needs vary greatly from one area to another, from one section to another, and from one family to another.

5. The teaching of sex education in the elemenatry school constitutes a controversial issue in many areas. School people should be aware of this fact as they consider the need for sex education and the ways in which it will be taught in the elementary school.

6. The school administrator is the key person on whom the proper functioning of a sex education program depends. He must, therefore, understand his own role in the program, and must see the far-reaching implications inherent in a sex education program. At present administrators are hesitant to move.

7. Teachers in preparation should develop greater understanding in the field of child growth and development, of which sex education is one phase.

8. A sex education program should never be undertaken unless the teachers are interested, have had some preparation in sex education, and enjoy community confidence.

The following areas are among those in need of immediate additional research as sex education assumes greater importance in the elementary school programs:

1. Teacher education institutions should prepare teachers in such a way that they will be better able to cope with the problem of sex education in our public schools.

2. Teacher education institutions should study the problem of in-service training in sex education for teachers now employed in the elementary schools.

3. Simple materials dealing directly with sex-related problems should be prepared for use in elementary-school classrooms.

4. Further study should be made of: (a) the place and effective use of audio-visual and other teaching aids in the schoolroom and in community-wide educational efforts; (b) the ways in which society can more effectively assist youth in solving its problem of reaching physical maturity before they normally are economically and educationally ready for marriage; (c) group dynamics in all phases of parent-teacher-youth relationships; and (d) the problem of how churches can contribute most effectively to the sex education needs of American youth.

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(Submitted 6-9-53)

A Test of Softball Batting Ability

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Abstract

There are few skill tests in softball. What are available have not included batting because the variability of the pitched ball has made test results unreliable. Using the commercial batting tee commonly used for batting practice, a reliable and valid test of batting skill has been set up. Directions for administering the test are given.

ALTHOUGH MOST PEOPLE would agree that batting is an important skill in the game of softball, most tests of ability in this sport do not include this skill. The reason for omitting this skill from the testing situation must be fairly obvious. Prior to the use of the batting tee any test of batting ability depended partially on the skill of the pitcher. As one of the criteria of a good test is that results should be dependent on the performance of the testee only, it has been impossible to satisfy this condition.

Another important criterion in setting up a test battery is that it should measure important abilities in the game. Very few would doubt that batting ought to be included in a softball test battery, but the difficulties in evaluating that skill have been too great. The batting tee is not only a good practice device but it makes possible the testing of batting ability objectively without being dependent on the skill of another performer than the person actually being tested.

An analysis of factors important in batting suggested several lines of approach to the problem of testing that skill. Among the factors thought to be important were ability to bat for distance, ability to place the ball and ability to bat and make an immediate get-away to first base. Tests were constructed to measure these three abilities. While all three tests were satisfactory as far as reliability was concerned giving reliability coefficients ranging from $r = .81$ to $r = .96$ (the number of subjects was 62), only one test, batting for distance, proved to be valid when correlated with judges' ratings of batting ability. As the judges were to rate the batter on grip, stance, swing, and consistency of hitting, it is possible that using a criterion that considered more factors, such as general playing ability, the tests of placement batting and batting and running might be more valid.

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[1]The authors wish to thank the following for their contributions to earlier forms of the test: Ellen Tatum, Martha Wetzel; and for judging: Lucille Magnusson, Nancy Rupp.

BAT FOR DISTANCE TEST

A. *Equipment.* An assortment of softball bats, a minimum of five good softballs, a standard batting tee. The batting tee consists of an aluminum tube projecting from the center of a rubber base which is regulation size and shape for home plate. An adjustable rubber tube is mounted on the aluminum tube. The softball to be batted is placed on top of the rubber tube.

B. *Field Marking.*

1. A base line on which the batting tee is placed.
2. Twenty lines three yards in length spaced ten feet apart and parallel to the base line.
3. Twenty lines one yard in length midway between the three-yard lines and parallel to them.
4. The distance from the base line is marked at the end of each of the three-yard lines.

C. *Administration.* Each player is given three warm-up hits at the ball on the batting tee. She may adjust the batting tee to any height during the practice hits. Five trials are then taken without pause.

D. *Scoring.* The distance from the batting tee to the place where each ball first touched the ground is recorded. The score is the sum of the distance of each of the five trials. It counts as a trial and no score is given if the bat strikes the batting tee instead of the ball or if the ball is missed completely.

E. *Reliability.* $r = .87$ when the Spearman Brown Prophecy Formula was used to step up the split halves method of computation. The 62 subjects used were from the service program or were majors in physical education at the State University of Iowa.

F. *Validity.* $r = .64$ when correlated with the sum of three judges' ratings. The number of subjects was 58. The players were from service classes and majors in physical education at the State University of Iowa.

G. *Comments.* It is assumed that the players will have had some experience and practice using the batting tee before the test is given. With a little training and practice in judging, students can administer this test themselves. This test must be administered out-of-doors because the distance needed is too great for indoors.

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(Submitted 7-15-53)

Influence of Athletic Training on the Resting Cardiovascular System[1]

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Abstract

Cardiovascular changes in 18 college athletes during training, compared with 15 controls, can be interpreted as the result of the interplay of basic factors (peripheral resisttance, aortic volume-elasticity, stroke volume and heart rate). The observed effects of athletic training seem to be due to increased elasticity and resting stroke volume associated with a compensating decrease in heart rate. Brachial pulse wave tracings (systolic amplitude) differentiate the athletes from the controls, but do not change by a statistically acceptable amount during training. Changes in the resting heart rate constitute a useful test of the cardiovascular aspect of athletic conditioning, the validity being $r = 0.76$.

CIRCULATORY ADJUSTMENTS to the stress of physical activity and the manner of return to the resting base line are important aspects of exercise physiology, because blood flow is closely related to the vital factor of oxygen transport to the body tissues. While the resting circulation is of less direct import, it is of interest because it may reflect (indirectly) certain physiological changes resulting from athletic training that are advantageous during exercise. The search for practical tests of training status or "physical fitness" has emphasized the resting circulation because of convenience of measurement. While it is beyond the scope of the present article to review critically the various studies in this direction, it is well known that they have in general proved disappointing.

Since the classical study of the Cambridge oarsmen (1) there have been numerous reports showing that athletic training has a very consistent depressing influence on the resting pulse rate (14). This may be considered to signify a more powerful and efficient heart that delivers a larger stroke volume. The influence of such training on the blood pressures is controversial —some studies show an increase and others a decrease—forcing textbook writers to avoid the question (10) or to take the tacit position that there is no significant change (13).

During the last few years, there has been considerable investigation, by the Illinois group, of the use of graphic pulse-wave tracings as measures of certain aspects of the resting circulation that are correlated with athletic condition (4, 5). These studies have been concerned with the differences between athletes and non-athletes, or between different athletes, rather than changes occurring within the individuals as a result of athletic training.

[1]From the Department of Physical Education. Acknowledgment is made to the University Committee on Research for financial support.

Theoretical Considerations

Blood Pressure and Heart Rate. Much of the confusion of the past may be avoided by realization that the systolic, diastolic, and pulse pressures are not in themselves of very great physiological importance in the physiology of athletic training. On the contrary, they are the *result* of the interplay of certain basic factors, namely stroke volume, heart rate, arterial elasticity and peripheral resistance. Following the Wezler and Böger cardiovascular dynamics and terminology as explained by Ralston, Guttentag and Ogden (12), the mean arterial blood pressure P_m (which is approximately equal to the average of the systolic and diastolic pressures) is accounted for by the equation

$$P_m = W V_s R \qquad (1)$$

where W is the total peripheral resistance (*Widerstand*) facing the aorta, V_s is the stroke volume of the heart and R is the heart rate per second (i.e. $r/60$).

Pulse pressure ΔP can be stated as

$$\Delta P = E V_s/2 \qquad (2)$$

where E is a volume-elasticity coefficient measuring the *rigidity* of the arterial tree (*windkessel*). It follows algebraically from these equations that the systolic blood pressure is

$$P_s = V_s (W R + E/4) \qquad (3)$$

the diastolic blood pressure is

$$P_d = V_s (W R - E/4) \qquad (4)$$

and the cardiac output in *seconds* units is

$$C = P_m/W = 2 R \Delta P/E \qquad (5)$$

Ralston *et al* have also shown that the ratio E/W has the property of independence of the stroke volume, as may be seen by the equation

$$E/W = 2 R \Delta P/P_m \qquad (6)$$

and have given several examples showing how this ratio reveals changes in peripheral resistance that are not apparent from the conventional interpretation of blood pressure changes. The present writer has recently used several of these formulae to interpret the blood pressure changes as reflecting more fundamental physiological alterations associated with the aging process (6).

It is not very practical to make routine determinations of the stroke volume with presently available methods during the course of an athletic conditioning program. While this limitation is unfortunate, it is not entirely disastrous. Some insight into the changes of the resting circulation may be achieved by utilizing the E/W ratio and certain modifications of the other formulae—in particular, the relationship

$$E V_s = 2 \Delta P \qquad (7)$$

which can be computed very easily from the blood pressures, and

$$W V_s = P_m/R \qquad (8)$$

which requires in addition the heart rate in beats per second.

Hypotheses. It is fairly well established by more direct methods that one of the physiological effects of training is an increase in the resting stroke volume V_s (15). Evidence of this change in the present investigation can therefore be taken as offering some degree of validation of the indirect method that will be used. This change should be associated with an equivalent or compensating decrease in heart rate. Consideration must be given to the possibility that the heart rate may decrease either more or less than this equivalent amount. Two additional hypotheses may be advanced, namely that training increases the volume-elasticity of the "arterial tree" or *windkessel* (*i.e. E* will *decrease*) and that increased vascularization resulting from athletic training (10, p. 277) may decrease the peripheral resistance *W*.

From the various formulae given above, it is possible to set up Table 1 to show the relative changes in blood pressures and derived circulatory measures as a result of various known changes or combinations of changes in stroke volume, heart rate, volume-elasticity and peripheral resistance. It may be anticipated that this table will prove to be of value in interpreting the experimental observed changes in the blood pressures and heart rate due to athletic conditioning, and in other circumstances also.

TABLE 1

Hypothetical Changes in Resting Cardiovascular Measures Caused by a 10% Increment of Improvement in Certain of the Basic Physiological Functions

Function	P_s	P_d	P_m	ΔP	EV_s	WV_s	E/W
Base value	125.	75	100	50	100	100	1.00
$V'_s = V+\Delta V$	12.5	7.5	10	5	10	10	NC
$R' = R-\Delta R$	− 9.	− 9.	−9	NC	NC	NC	NC
V'_s and R'	2.5	− 2.5	NC	5	10	10	NC
$W' = W-\Delta W$	−10	−10	−10	NC	NC	−10	0.10
W' and V'_s	2.5	− 2.5	NC	5	10	− 1	0.11
W', V'_s and R'	− 7.5	−12.5	−10	5	10	− 1	0.11
$E' = E-\Delta E$	− 2.5	2.5	NC	−5	−10	NC	−0.10
E' and V'_s	10	10	10	−0.5	− 1	10	−0.11
E', V'_s and R'	NC	NC	NC	−0.5	− 1	10	−0.11

Pulse Wave Tracings. The use of the direct-writing pulse wave recorder has been described in detail in several publications from the Illinois Physical Fitness Laboratory (4, 5; *also see* 8) and bibliographical references concerning theory will be found in those publications. A large variety of measures can be secured from the recorded pulse wave. One of the simplest of these is the *systolic wave amplitude.* Massey, Husman and Kehoe (8) have recently reported evidence that this measure is correlated with stroke volume and is related to "physical fitness" defined as ability to run 880 yards. An earlier study showed a substantial correlation with performance in the all-out treadmill run (5, *p. 251*).

Methodology

Subjects. The experiment to be described involved 33 male university students. Eighteen of them were tested both before and after a season of competitive athletics (5 distance or middle distance runners, 5 wrestlers or boxers, 5 baseball players and 3 water polo players). It should be mentioned at this point that the results showed ample evidence of cardiovascular changes associated with the athletic conditioning program. The other 15 men were athletically inclined and physically active. Although they continued their usual recreational sports activities between test and retest, they did not engage in any systematic training regime and did not show evidence of any important cardiovascular changes. In particular (as will be shown presently), the two groups did not differ significantly with respect to heart rates and blood pressures at the time of the initial test. Two experimental designs are therefore possible.

Experimental Design. One possibility is a statistical analysis of the test-retest differences within the experimental group, using the other group as a control to rule out the possibility of seasonal cardiovascular changes, "first test" effects or changes in techniques.

The second design compares differences between the two groups at the time of the retest. This method has the disadvantage of greater error variance, but explicitly corrects for changes in the control group and offers the possibility of evaluation of the measures in the form of conventional validity coefficients (*biserial r*). The data have been analyzed according to both of the designs.

Heart rates, blood pressures, and brachial pulse wave tracings were obtained on a recording sphygmograph,[2] with the subject in the seated position, after at least 10 minutes of quiet rest. The technique was as nearly as possible in accord with the Illinois recommendations (4).

Experimental Results

Within-Group Changes. Descriptive statistics for the two groups of subjects are given in Table 2. In addition to the blood pressures and functions computed from them, the table gives various measurements of the brachial pulse wave tracings emphasized by the Illinois group, including of course the systolic pulse wave amplitude. The changes and t ratios appear in Table 3. In the training group, since the direction of the difference in pulse wave tracings and heart rates is predicted by hypothesis (singled tailed distribution), a t ratio of *1.74* is statistically significant (*5%* level of confidence) and a ratio of **2.57** is highly significant (**1%** level of confidence). The blood pressures and functions derived from them require a two-tailed statistical hypothesis. EV_s and WV_s involve one factor expected to increase and another ex-

[2]The writer is indebted to the Cameron Heartometer Company, Chicago, for their kindness in loaning one of their *Heartometer* instruments for use in the investigation and for furnishing the recorder charts.

TABLE 2
Descriptive Statistics

Measurement or function	Experimental (N=18)				Control (N=15)			
	Test		Retest		Test		Retest	
	M	SD	M	SD	M	SD	M	SD
P_s—Systolic Pressure (mm)	126.5	8.38	125.6	7.10	122.8	9.10	121.4	8.54
P_d—Diastolic Pressure (mm)	69.8	8.28	72.4	5.40	73.0	8.78	75.6	6.62
P_m—Mean Pressure (mm)	98.2	6.14	99.0	4.24	97.9	5.68	98.6	5.54
ΔP—Pulse Pressure (mm)	56.7	9.64	53.2	9.40	49.8	9.46	45.8	10.46
R—Heart Rate (per sec.)	1.210	.166	1.060	.117	1.315	.216	1.300	.203
r—Heart Rate (per min.)	72.6	9.98	63.6	7.03	78.9	12.98	78.0	12.18
EV_s—Volume Elasticity × stroke volume	113.4	19.28	106.4	18.80	99.6	18.92	91.6	20.92
WV_s—Peripheral Resistance × stroke volume	83.0	13.08	94.9	12.99	76.8	14.85	77.9	14.61
E/W—Rigidity/Resistance Ratio	1.382	0.298	1.153	0.175	1.349	0.363	1.191	0.333
SA—Systolic Wave Amplitude (cm)	1.398	0.363	1.458	0.280	1.209	0.284	1.122	0.345
DA—Diastolic Wave Amplitude (cm)	0.602	0.217	0.709	0.177	0.466	0.196	0.471	0.202
DS—Diastolic Wave Surge (cm)	0.234	0.160	0.280	0.178	0.151	0.151	0.126	0.173
DN—Dicrotic Notch Amplitude (cm)	0.368	0.173	0.430	0.131	0.315	0.120	0.345	0.121
DN/SA—Ratio	0.278	0.129	0.296	0.103	0.273	0.113	0.330	0.127

TABLE 3
Statistical Analysis of Differences

NOTE: Italics indicate a statistically significant difference; bold-faced type indicates a highly significant difference.)

	Within-group difference				Between-group difference				
	Experimental		Control		Pre-training		Post-training		
	Diff.	t	Diff.	t	Diff.	t	Diff.	t	r
P_s	−0.9	0.66	−1.4	0.65	3.7	1.17	4.2	1.47	0.325
P_d	2.6	1.20	2.6	1.65	−3.2	1.04	− 3.2	1.51	−0.327
P_m	0.6	0.50	0.7	0.39	0.3	0.14	0.4	0.22	0.051
ΔP	−3.5	1.10	−4.0	1.22	6.9	2.00	7.4	*2.04*	*0.456*
R	−0.15	**3.94**	−0.02	0.57	−0.11	1.49	− 0.24	**3.92**	**−0.758**
r	−9.0	—	−0.9	—	−6.3	—	−14.4	—	—
EV_s	−7.0	1.10	−8.0	1.22	13.8	2.00	14.8	*2.04*	*0.455*
WV_s	11.9	**4.38**	1.1	0.64	6.2	1.22	17.0	**3.39**	**0.660**
E/W	−0.229	**3.19**	−0.158	1.51	0.033	0.51	− 0.038	0.46	−0.089
SA	0.060	0.81	−0.087	1.16	0.189	*1.72*	0.336	**2.94**	**0.596**
DA	0.107	*1.98*	0.011	0.09	0.136	*1.83*	0.238	**3.45**	**0.674**
DS	0.046	1.28	−0.025	0.97	0.083	1.51	0.154	*2.45*	*0.502*
DN	0.062	*1.94*	0.030	0.88	0.053	1.21	0.085	*1.88*	*0.398*
DN/DS	0.018	0.60	0.067	1.22	0.005	0.11	− 0.034	1.05	−0.185

pected to decrease, hence might go either up or down. For these measures, and for E/W, the criteria are *2.11* (*5%*) and **2.90** (**1%**).

In the control group there are two statistical hypotheses to be tested. For the first (which asks if there are changes in the physiologically correct directions) a t ratio of *1.76* is significant and one of **2.62** is highly significant. For the second (which asks if there are changes in *either direction* greater than expected from random sampling) a t ratio of *2.15* is significant and one of **2.98** is highly significant.

According to these statistical criteria, there are no significant changes between test and retest within the control group. In the experimental group, the athletic training regime has produced highly significant changes in heart rate, E/W, and the WV_s function, as well as significant increases in the diastolic wave and dicrotic notch amplitudes (DA and DN).

Between-Group Differences. For the heart rate and brachial pulse wave measures, where the direction of a difference due to training is predicted by hypothesis, t ratios of *1.70* and **2.45** are significant at the *5*-per-cent and **1**-per-cent levels of confidence, respectively. For the blood pressures and derived measures, the required t ratios are *2.04* and **2.75.**

After training, there are highly significant differences in heart rate (R), the product of peripheral resistance and stroke volume (WV_s), and several of the brachial pulse wave measures . Only the latter show any pretraining differences of statistical significance. While the E/W difference is in the same direction as the within-group change due to training, it is not large enough to be statistically significant. There is a difference of borderline significance in the case of pulse pressure and EV_s, but this difference was present at almost the same magnitude before training; hence it cannot be attributed to the conditioning program.

Height-Weight Differences. The athletes weighed 163 lb. initially, on the average, and decreased 1.7 lb. during training ($t = 1.6$). The controls averaged 6 lb. lighter ($t = 3.5$) and decreased 1.4 lb. during the period of observation ($t = 1.4$). The two groups both averaged 70.6 inches in height. In this study, therefore, training has had no significant influence on body weight or surface area. The athletes are 3.7 per cent heavier, but well matched with the controls in height and surface area.

Correlations. Because of practical interest in the possibility of using some of the cardiovascular measures as tests of athletic condition or "cardiovascular fitness," biserial correlation coefficients have been computed for the post-training situation. (See last column of Table 3). Their interpretation and use will be discussed later. The statistical criteria for significance are $r = 0.317$ for the *5* per cent and $r = \mathbf{0.540}$ for the **1** per cent levels of confidence, the algebraic sign of the correlation being predicted by hypothesis for the items that appear useful as tests of athletic conditioning (heart rate, WV_s, and the systolic and diastolic wave amplitudes).

Discussion of Results

Physiological Changes. Referring back to Table 1, it will be seen in the bottom line that an increase in stroke volume associated with a compensating decrease in heart rate, when coupled with an increased arterial volume-elasticity (a reduction in E) results in a larger WV_s, a smaller E/W ratio and no alteration in the blood pressures. There is little or no change in EV_s, because the increased stroke volume is accommodated by the increase in elasticity. Since this pattern is unique and is the only pattern matched by the experimental observations, the indirect evidence requires the conclusion that training has caused the cardiovascular changes listed above. In contrast, the pattern of observed cardiovascular changes gives no indication of any decrease in peripheral resistance; the alterations in E/W are in the wrong direction.

Another approach can be gained by examining the influence of training on the mathematical product of cardiac output and volume-elasticity (CE) compared with the influence on cardiac output and vascular resistance (CW). Using equation 5 and certain of the other relationships, it is possible to write

$$CE = 2R\Delta P \qquad (9)$$

and, using for convenience the term Q to denote the experimentally observed magnitudes of the E/W ratio,

$$CW = 2R\Delta P/Q \qquad (10)$$

In these two equations, the magnitudes of all of the right-hand terms are known from the experiment. Making the appropriate numerical substitutions from Table 2, the before-and-after training figures for CE are 137.1 and 112.7, to be compared with CW figures of 98.2 before training and 99.0 after training. Since the units are comparable in both equations (C is in cc/sec and both E and W approximate unity in the ideal normal case), it is obvious just by inspection that there has been a large decrease in CE and little or no change in CW. The simplest and most straightforward explanation for this result is of course that W and C have not been appreciably influenced by athletic training whereas E has decreased (*i.e.* volume-elasticity has increased).

It is necessary, however, to at least consider an alternative explanation. Postulating that there has been a decrease in peripheral resistance W associated with a compensating increase in C leaves the product CW unchanged but implies a much larger decrease in E than has occurred according to the first explanation. The second possibility in reality reinforces the first, *i.e.* E has decreased in any case. In other words, it can be postulated that C and W have remained unaltered, but if it be assumed that W has decreased, then C must have increased and there must have been an even larger decrease in E. Only the first of these theoretical explanations is consistent with the pattern analysis, in the present experiment.

It is not possible to calculate absolute magnitudes for the cardiac output unless either E or W (or V_s) is of known magnitude. In order to make the

theoretical implications less esoteric, some physiologically reasonable magnitude for one of these variables can be postulated; for instance W may be assumed to be 0.900 in both first test and retest, in both groups. (This assumption of a constant magnitude is not without justification. The average deviation of the four group means from the grand mean is only 0.4 for the CW function compared with 9.6 for the CE function). Substituting 0.900 for W and using the experimentally observed $R\Delta P$ and E/W figures from Table 2 in the various formulae yields the results shown in Table 4, and permits the exact computation of any of the other blood pressures or cardiovascular functions given in Table 2. (In making these calculations it is necessary to compute E/W and WV_s from the mean values of ΔP, P_m and R. Use of the averages of individual scores gives slightly different results because the ratio of means is mathematically different from the mean of ratios).

TABLE 4
Calculated Physiological Factors
(Assuming $W = 0.900$ in all cases)

Factor	Experimental		Control	
	Test	Retest	Test	Retest
E (Volume-elasticity)	1.257	1.025	1.204	1.087
C (Cardiac output cc/sec)	109.2	110.0	108.5	109.5
V_s (Stroke-volume cc)	90.2	103.8	82.5	84.2

It should be mentioned that while the figures for V_s are somewhat higher than usually given in textbooks (*i.e.* 60-70 cc) they are not at all unreasonable, being only slightly above *basal* data published by Cournand, Ranzes and Riley (3). Moreover, since the subjects were either athletes or athletically active, their stroke volume would be expected to be somewhat higher than average.

The above results indicate that training has resulted in an increase of about 18 per cent in volume-elasticity and 15 per cent in stroke volume (the latter being compensated by a decreased heart rate). Thus two of the hypotheses are confirmed, and the third (predicting a decrease in peripheral resistance) is denied. It is of course quite possible that younger subjects or subjects who were in poorer physical condition prior to training might exhibit a different pattern of physiological changes. The type of training could also influence the results.

Calculations from the data of a study by Cogswell, Henderson, and Berryman (2) reporting pre- and post-training heart rates and blood pressures show a decrease in EV_s and E/W and an increase in WV_s as in the present investigation, but with *decreased* rather than unchanged blood pressures. The interpretation must be somewhat uncertain since it is not known which changes are or are not statistically significant; furthermore the training was not very rigorous in that experiment. The somewhat older report by Stewart and Watson (15) also permits calculation of the cardiovascular factors. Athletes (compared with nonathletes) have a lower R, EV_s and E/W, with a

slightly higher WV_s. Direct computation of E and W are possible in this case, since V_s was measured. The athletes have 12 per cent larger stroke volume (V_s). The volume elasticity, computed by the present writer, is 24 per cent larger, *i.e.* E is smaller ($t = 2.68$) and peripheral resistance W is 9 per cent less ($t = 1.87$). The function CE is smaller ($t = 2.12$) whereas CW does not differ ($t = 0.48$). Owing to the relatively large increase in elasticity, the systolic and pulse pressures should theoretically be lower in the athletes, and are observed to be lower. Very likely the same explanation accounts for the lower blood pressures in the Cogswell experiment. Had the stroke volume difference been relatively large compared with the elasticity difference (instead of relatively small as in the present case), the blood pressures would have been *higher* instead of lower, even though stroke volume and elasticity increased in both cases.

Careful study of Table 1 reveals that another important factor is the exactness of the compensation of heart rate decrease relative to stroke volume increase. In the present experiment the compensation was almost exact; with less reduction in rate the blood pressures would have increased and with more reduction they would have decreased.

It is not uncommon to find athletes with higher-than-average blood pressures; champion athletes are higher than nonchampions and both groups are higher than normal controls (4, *p. 200; also see* 5). There is no theoretical reason why training should not sometimes increase and sometimes decrease the pressures. Both changes have been observed (11). Usually, however, training causes a decrease; Cureton *et al.* (4, *p. 222* ff.) as well as others (11), have presented evidence of this tendency. These examples show the fallacy of attempting to interpret the blood pressure changes or differences in themselves, rather than as a result of the physiological factors responsible for them.

Significance of Pulse Pressure and Diastolic Pressure. The Wezler-Böger dynamics represent a straightforward application of physical laws to the circulatory system. There is no mystery involved. As presented, there is no attempt to explain how or why peripheral resistance or arterial elasticity undergoes a change. Even at the present level of explanation, however, it is possible to gain a rather clear insight into what can and cannot be inferred from the blood pressure.

The writer (quite understandably) wishes to avoid any embarrassing specific citations of the literature, but feels the necessity of pointing out that one not uncommon mistake has been to identify *pulse pressure* with *stroke volume*. It is indeed proportional to V_s when arterial elasticity is constant, but there is every reason to believe and no reason to deny that elasticity varies considerably between individuals and may change drastically in an individual over a period of months or years. Diastolic pressure has sometimes been considered to be a measure of peripheral resistance or some other physiologically important factor. The facts of the matter (as may be seen in the vertical column labeled P_d in Table 1) are that a change in any one of the four basic

factors causes a change in diastolic pressure, and inferences range from difficult to impossible in such a situation.

Pulse Wave Differences. The changes and differences in brachial pulse wave tracings indicate that the alterations due to training are relatively small and inconsistent; the difference between the athletes and controls *before* training is larger than the change due to training. Since the changes are without exception in the same direction as the differences (and are all in the "physiologically correct" direction), the most reliable differences are of course found in the post-training comparison of the two groups (Table 3).

The findings of the present study suggest two possibilities. Potentially good athletes (insofar as they may be characterized by their pulse-waves) have this advantage inately, or at least before training. The alternative explanation is that a relatively small amount of training is sufficient to produce near-maximal improvement in such aspects of the cardiovascular system as are revealed by the pulse-wave tracings, and further training has little influence. While the available data do not entirely justify a choice between these possibilities, it seems likely that the heart rate-blood pressure items are more sensitive to athletic training whereas the pulse wave magnitude is more effective in distinguishing between athletes and other types of individuals.

Results of the present investigation definitely confirm the Illinois results with respect to greater systolic and diastolic wave amplitudes and diastolic surge in the athletes. The absolute magnitudes for athletes "in condition" are definitely higher than the reported figures for nonathletes, and only slightly lower than the 1948 track and field champions (5, *p. 237*). The position is about two-thirds of the way up between the nonathletes and the champions, which is about where subjective judgment of the athletic status and training of the present subjects would place them. Observation of significant differences between athletes and controls agrees with the recent report of Massey, Husman, and Kehoe (8) although their mean values run somewhat higher than the present ones (and are indeed higher than the magnitudes reported for the champions). It may be noted that Massey *et al.* used a relatively rigid "snap-on" blood pressure cuff. No doubt the discrepancy in absolute magnitudes is due to this or to some other technical difference.

Test Validity. One practical application of a study such as the present one is of course in the field of testing. Since the experimental and control groups were undifferentiated in heart rate and blood pressure prior to conditioning, the biserial correlation coefficients computed from the post-conditioning measurements constitute validity coefficients. The highest of these is $r = 0.758$, for the pulse rate. This is a very respectable magnitude for a cardiovascular test item.

Many studies have found low validity for resting heart rate as a test, as for example the recent investigation of Massey *et al.* (8). The cause of failure is due to the fact that such studies have typically used a performance criterion, and the pulse rate is *not* a valid test of performance. It does, however, have validity as an indirect measure of *athletic conditioning;* in fact it is prob-

ably a better general test for this purpose than any performance test. Shortcomings of the latter have been critically discussed elsewhere (7). True, the pulse rate is not a perfect test, but it deserves a better reputation than is current.

As a result of experience at this laboratory, we have come to have considerable reliance on change in the resting heart rate as an index of the physiological effect of conditioning. One study done several years ago showed correlations of $r = 0.76$ and $r = 0.33$ in two experiments relating *changes* in resting heart rate with *changes* in athletic condition estimated by time trials in varsity track men (16, *p. 31*). Two other studies, done more recently under the direction of the writer, found statistically significant reductions in the resting rate as a result of a period of athletic conditioning (9, 11). Other investigators (as cited in the introduction) have almost invariably found the same effect.

There is little point in blindly attempting to combine several cardiovascular items into a test battery under the assumption that better prediction can hereby be attained. The various items are in general too highly intercorrelated to justify any such hope. For example, in the present experiment, the physiological explanation of the validity of the heart rate change is probably that it decreases in proportion to an increased stroke volume. The latter is of course of no particular value at rest, but it is indicative of the development of a more efficient and more powerful heart, which *is* advantageous during exercise. While we do not know just how highly the heart rate R and the stroke volume V_s *are* intercorrelated, the relation of R to the factors containing V_s (*i.e.*, WV_s and EV_s) can be determined.

With the first of these the relation is high and negative as anticipated ($r = -0.939$). With the second, conditioning not only increases V_s but also *decreases* E, so that the total function tends to remain unaltered, the relation is diluted, and the correlation falls to $r = -0.449$ between R and EV_s. Because of this situation, the validity of EV_s is also low as a test of conditioning ($r = -0.455$). It was considerably higher for WV_s ($r = 0.660$) because W tends to remain constant while V_s increases. Combining either EV_s *or* WV_s with R does not increase the validity appreciably as compared with using R by itself because the physiology of the situation results in intercorrelations that are high, relative to the item validities.

It had been hoped that R could be combined with the E/W ratio, since the latter *is* independent of V_s. Although changes in both E and W would tend to cancel, the combination would be effective should there be no change in W. The changes observed within the experimental group do support the virtue of this combination, but unfortunately the decrease of E/W in the control group (even though it is not statistically significant) invalidates the item in the inter-group comparison. The writer is inclined to the opinion that more extensive samplings of conditioning data may afford justification for using the E/W ratio; the idea still appears to be theoretically sound.

There is some slight improvement in test battery validity if the heart rate

R is combined with one of the brachial pulse-amplitude measures. The most promising item is systolic amplitude, which intercorrelates only $r = -0.396$ with R and has a validity coefficient of $r = -.596$; the resulting multiple correlation is 0.824. While this is not a very spectacular increase in validity as compared with the best zero order coefficient, this combination offers the common sense advantage of distributing the eggs between two baskets. It should also be mentioned that systolic wave amplitude and heart rate are two of the easiest measures to obtain from the pulse wave chart, which is a practical point of importance.

Diastolic pulse wave amplitude has a higher zero order validity than systolic amplitude ($r = 0.674$ compared with 0.596). It turns out, however, that it is not as effective an item in the test battery. The combination of heart rate and diastolic wave amplitude yields a multiple correlation of only 0.796, because of the higher intercorrelation between these two items ($r = 0.650$ compared with 0.396). Diastolic amplitude, moreover, is not as easily measured from the charts because of its smaller magnitude.

Two-Item Test. Although no regression equation is possible when biserial correlations are used, the beta coefficients and standard deviations of the test items are available. These predict the optimum score weightings as 0.1 $\times$ heart rate (per minute) and 4.6 $\times$ systolic wave amplitude (in cm). With the present data, a good approximation to this ratio of weighting would be secured by simply adding standard scores in the two variables. Combination of systolic and diastolic amplitudes does not raise the multiple correlation appreciably because of the relatively high intercorrelation ($r = 0.843$) between these items.

Reliability. The cardiovascular measures were secured on two additional occasions, namely one or two weeks after the first test and one or two weeks before the final retest. Two sets of test-retest reliability coefficients have accordingly been computed and averaged geometrically. For systolic wave amplitude, $r = 0.74$ compared with 0.76 reported by Massey, Husman, and Kehoe (8) and the considerably higher values cited by them as reported in other studies. The heart rate reliability is $r = 0.67$; Massey *et al.* found 0.50, and mention other studies reporting as high as 0.996. (The latter figure is undoubtedly much higher than can ordinarily be expected.) Systolic and diastolic blood pressures show reliabilities of $r = 0.62$ and 0.65, which are fairly close to the coefficients from two other sets of data, which give an average $r = 0.70$ for systolic and 0.68 for diastolic (4, *p. 215* ff.).

Considering the size of these coefficients, it is evident that a single test on one day is inadequate for measuring the status of an individual subject. By the Spearman-Brown method it can be estimated that six measurements should be averaged in order to secure a reasonably dependable individual score, the predicted coefficient being $r = 0.92$. The weakness of the test in this respect is not due to inadequacy in the technique of measurement; instead, it is due to fluctuations in the underlying physiological processes. The cardiovascular system is responsive to a large number of environmental factors, and these

must be averaged out over a period of several days before any conclusions can be drawn concerning individual differences in cardiovascular function within the normal range.

Summary and Conclusions

Blood pressures, heart rates, and pulse wave sphygmograms at rest were obtained on 18 college athletes before and after a season of athletic training and competition, and compared with the test-retest measurements of a control group of 15 physically active men. A pattern analysis was made of the observed changes and differences, as compared with certain theoretical patterns derived from the cardiovascular dynamics of Wezler and Böger. The results are theoretically consistent.

The experiment fails to produce any evidence that training causes a decrease in peripheral resistance that might have resulted from improved vascularization. There *is* evidence of increased arterial elasticity, and of increased stroke volume associated with a compensating decrease in heart rate. Conflicting experimental results on blood pressure changes that have led to confusion in the literature can be reconciled by the *ad hoc* hypothesis that while athletic training increases both elasticity and stroke volume, some difference in the proportionality of the changes and in the amount of heart rate decrease is inevitable. The blood pressures are the *result* of the interaction of heart rate, stroke volume, arterial elasticity, and vascular resistance.

Observations reported by others as to the characteristic pulse wave sphygmograms of athletes are statistically confirmed. Training, however, does not alter them very much; the changes are less than the pre-existing differences and only of of borderline statistical significance. It seems necessary to conclude that the decrease in heart rate (which reflects the development of a more powerful heart with a larger stroke volume) is a more effective test of *changes* in athletic condition, whereas the sphygmograms chiefly test aspects of the resting circulation that differentiate successful athletes from other individuals.

The heart rate-blood pressure measurements can be used to calculate several physiologically significant cardiovascular functions defining the resting circulation. The test-retest reliability is not particularly high, however, and it is necessary to secure measurements on six different days in order to define individual differences with adequate precision (represented by $r = 0.92$). The average of a four-day test with the sphygmograph pulse wave amplitude would have the above reliability. The resting heart rate has significant validity as a test of the effect of athletic training ($r = 0.76$). Owing to high intercorrelations, this validity is improved very little by adding items derived from the blood pressures. The highest syphygmogram validity is $r = 0.67$. A two-item test combining heart rate with systolic pulse wave amplitude has a validity of 0.82, and would seem to offer possibilities as a practically useful test.

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(Submitted 7-14-53)

Visual Movements of Batters[1]

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Abstract

Observational analysis of university batters in game situations and cinematographic analysis of professional batters in batting practice showed that, in tracking a pitched ball, batters used pursuit movements of the eyes with the head essentially fixated. However, in no instance was the ball tracked clear up to contact with the bat. Tracking movements of the eyes stopped while the ball was still 8 to 15 feet from the plate, either because further tracking would provide no useful information after the bat was under way, or because pursuit movements of the eyes break down at such high relative velocities.

THE BATTER AWAITING a pitched ball has two problems, one sensory-perceptual and the other motor-response. The sensory-perceptual problem consists of visually tracking a ball that increases in apparent size and traverses the visual field. The batter must predict where and when to swing, and whether or not to swing, primarily on the basis of observable differences in the rate of increase in size. On the motor response side, he must generate momentum in the bat and direct its swing to meet the ball. The sensory and response aspects may be separated for analysis, but in the batting situation the batter's step and "wind-up" for the swing must occur while the sensory-perceptual process is under way. This complicates the problem for both the analyst and the batter, since tracking the ball and batting must proceed, at least in part, simultaneously and each may affect the other.

Previous analyses of batting have concentrated on the motor response side and largely neglected the visual-perceptual problem. Some interesting points were made in a series of studies of batting reaction time (12, 13). However, batting is not primarily a reaction-time problem. The stimulus object (ball) is continuously visible during its flight, not suddenly presented. Consequently, the problem is one of tracking a moving object, predicting its course and, at some point in its flight, deciding to swing or not. This prediction subserves the motor response. Although generating momentum in the bat, and the preceding central processes, involve some duration, any sensory component in reaction time is essentially eliminated. In other words, estimates based on reaction time of when the batter must make his decision and start the processes which will result in the swing place the point too far back in terms of ball flight.

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[1]This study is based, in part, on material presented in a Master's thesis written by Charles N. Seng and supervised by Dr. Alfred W. Hubbard, School of Physical Education, University of Illinois, Urbana, Illinois.

Although visual ability is obviously essential in batting, the study by Winograd (16) showed that some varsity players had poor vision and failed to show that factors measured had much relation to batting ability. There may be some minimum essential ability, but differences in batting ability probably depend primarily on perceptual ability (vision plus experience), perceptual-motor coordination, and motor ability.

Baseball books and articles specify that the ball should be tracked *until hit or past the plate* (1, 3, 5, 6, 11) but do not specify *how* this is done or the best method for doing it. The batter could use several types of head and eye movements or combinations of the two. He might keep the eyes essentially fixated with respect to the head and track the ball with pursuit movements of the head (like spectators at a tennis match). If he used eye movements, they might fall in one of three familiar classifications, namely: pursuit movements, saccadic jerks, or compensatory movements. At this point there are two neat questions, namely: first, whether man's visual mechanisms are capable of tracking, by any means, objects traversing the visual field at the rate of a pitched ball *near* the plate; and second, whether, if it were possible, tracking *to contact* with the bat would serve any useful purpose. However, before various limiting parameters can be interpreted, it is necessary to know which parameters apply, or what eye, head, or eye and head movements are involved in tracking a pitched ball.

Purpose of the Study

The primary purpose of the present study was to determine the visual basis for tracking a pitched ball in terms of head and eye movements. Other data on batting—the timing of the step and swing, and the speed of the ball—were computed in order to determine the temporal relations between the visual (perceptual) movements, the stimulus object (pitched ball) and the movements of batting (response movements). There was also the problem of developing a reliable method of recording head and eye movements in a batting situation. Four methods were tried. Since the findings by each method depended, to some extent, on the method used, each method will be described in connection with the related findings.

Methods Used

1. ELECTROMYOGRAPHY

The usual, optical method of recording eye movements was obviously unsuited. Muscle action potential recordings from the extrinsic muscles of the eye have been reported to be a reliable substitute (10). Surface and subcutaneous electrodes were used in a laboratory situation while the subject watched a stimulus object which simulated the last half of the flight of a ball. In both instances, an electrode was placed lateral to the eye and another electrode was placed either in between the eyebrows over the bridge of the nose or just over the eyebrow above the center of the eye. The subject took a batter's stance, looking to the left, and was instructed to watch a stimulus object

traversing a 30-ft. stretched wire as he would a baseball approaching the plate.

Definite indications of eye movements were obtained with subcutaneous electrodes, but only when the subject kept his head still and moved only his eyes. Otherwise, action potentials from blinks, jaw movements, eyebrow and head movements masked the desired action potentials. Furthermore, the laboratory situation was not analogous to batting since the batter could not strike at the "ball"; he was not even required to make the decision to swing, and the equipment around the eyes could not be used in an actual batting situation.

2. OBSERVATION UNDER GAME CONDITIONS

Since a player could keep the eyes fixated with respect to the head and track the ball with a pursuit movement of the head, a method was developed for determining whether this occurred in actual game conditions. If the batter tracked the ball to the plate by turning his head, this movement would be observable. The method consisted simply of observing batters in games and recording whether or not the head turned and whether or not they swung. (The call of the umpire was also recorded in case they did not swing.) Forty-two university and 59 professional players were observed in two university and three major-league games. Although the method provided no information as to possible eye movements, it was both objective and reliable, since two recorders working independently obtained identical results.

The data could be summarized in a series of two by two tables. (See Table 1.) The tabulation indicated pretty conclusively that players who swung at the ball did not track the ball to the plate with gross head movements. There were only 2 "swing-head turn" couples out of 556 observations. On the other hand, batters who did not swing turned their heads to track the ball across the

TABLE 1

Summary of Observations of Head Movements of Players Under Game Conditions

A. All pitches	University			Professional			Both		
	Head turn			Head turn			Head turn		
Swing:	No	Yes	Subtotal	No	Yes	Subtotal	No	Yes	Total
Yes	210	2	212	344	0	344	554	2	556
No	79	173	252	177	219	396	256	392	648
Total	289	175	464	521	219	740	810	394	1204

B. Pass balls only (no swing)		No head turn	Head turn with ball	Head turn late
Call:				
Ball	No.	182	158	104
	%	71.1	63.5	72.7
Strike	No.	74	91	39
	%	28.9	36.5	27.3

plate in a ratio of about 8 turns to 5 no-turns, although the difference was primarily a matter of turning the head after the ball passed—presumably to see where it was caught. And regardless of whether the batter let the ball pass without turning his head, or let it pass and tracked it with a head movement or turned his head late, the called pitches were in the ratio of two balls to one strike.

Although this method eliminated rather conclusively the possibility of a batter tracking the ball to the plate with head movements when he swung, it provided no positive evidence of how the ball was tracked. The batter might track the ball during its early flight with slight unobservable head movements. it did indicate that, if the ball were tracked to the plate, it must have been done on the basis of some type of eye movements.

3. ANALYSIS OF PUBLISHED PHOTOGRAPHS

Published photographs of ten major-league batters were studied to determine whether they might provide some lead as to the basis for visual perception in batting, especially possible eye movements. The pictures were apparently enlarged frames from motion pictures and the batters were: Johnny Groth and George Kell (3), Joe DiMaggio (8), Babe Young, Johnny Mize and Sid Gordon (4), Stan Musial and Ted Williams (7), Bobby Thomson (15), and Ralph Kiner (14).

The published pictures seemed to indicate that most batters showed some slight turn of the head, although it did not appear that the head movements were instrumental in tracking the ball, especially close to the plate. It was almost impossible to tell whether or not the eyes moved since the pictures were taken from across the plate with the player's face in profile. Also, there was no indication of where the ball was or how far it had progressed from the pitcher to the plate since the number of frames omitted between the published frames was not given. The defects of these pictures, as far as the immediate problem was concerned, suggested that a nearly full-face view of the batter, a view sufficiently close to show eye details and sufficiently far to show the whole body, and that some method of determining ball speed and position with relation to the batter were needed.

4. CINEMATOGRAPHY

A. *Method*

1. *General.*—Consent was obtained from officials of three major league clubs to take motion pictures during batting practice, but since it was necessary to be on the diamond to get the best camera angle, pictures during actual games were prohibited. It was assumed that the reactions in batting practice would approximate closely those in a game.

Five hundred feet of 35 mm film was taken with an Eyemo Camera during September 1951, at Sportsman Park in St. Louis, Missouri. From this film, 49 sequences of 10 St. Louis Cardinal players, 23 sequences of 10 Chicago Cubs players, and 56 sequences of 9 St. Louis Browns players were obtained. Of the 128 sequences, 121 were usable, but 39 were incomplete—failed to

show the pitcher or his release of the ball. Of the 82 complete sequences, showing the pitcher and batter from start to finish, 70 were hits and 12 pass balls.

The movies were taken at settings of 24 and 48 frames per second. Those at 48 frames per second were reduced to 24; and the number of frames from release of the ball by the pitcher to the plate or hit provided a more convenient temporal base than fractional seconds, so it was used. The camera speed was timed with a falling object and found to be sufficiently close to rated speed so that ball speed in miles per hour could be computed as 981.81 divided by the number of frames from release to plate—assuming 60 feet as the distance the ball traveled and 1/24 second as the time between frames.

The camera and operator were protected by a movable screen which was set as shown in Figure I. Pictures of right-handed batters were taken from the first base side, and left-handed batters from the third base side. The mirror (two by three feet with a two-inch square frame and plywood back) was set six feet high at the center behind the movable screen. The mirror provided a simultaneous view of the pitcher and ball flight, and of the batter and his motions, thus making it possible for the operator to start the camera with the pitch and later to compute the speed of the pitch and determine the temporal relations between the flight of the ball and the movements of batting. The mirror had to be readjusted on signals from the operator when the camera was shifted from one side of the diamond to the other, and some sequences were either lost or incomplete because of improper adjustment. The situation was improved by having the right-handed batters bat, then the left-handed.

2. *Analytical Method.*—Positive 35 mm. film was printed from the negative films. The positive film was projected on a 5x7 ft. screen and viewed by two observers to determine which sequences were complete (i.e., showed the pitcher and batter from start to finish) and which were incomplete (i.e., failed to show the pitcher, or were fragmentary). The major part of the analysis was confined to complete sequences in which a hit occurred (70), although some incomplete sequences were also included if a hit occurred and the beginning of the batter's step was visible. In the complete sequences, "frame 0" was taken as the last frame in which the ball was visible in the pitcher's hand, frame 1 as the first frame showing the ball released, and the "Hit" (H) or "Pass" (P) as the first frame after contact with the ball, or as the ball passed the plate. This procedure provided a basis for computing ball speed and establishing the temporal relations of the swing and eye-head movements. Incomplete sequences which showed the beginning of the step were included in some analyses.

3. *Batting movements.*—Three "points" in the batting movements were determined on the basis of the following criteria: the start of the step (X) was taken as the frame in which the lead foot was clearly off the ground; the finish of the step (Y) was taken as the first frame which showed the lead foot planted; and the start of the swing (Z) was taken as the first frame in

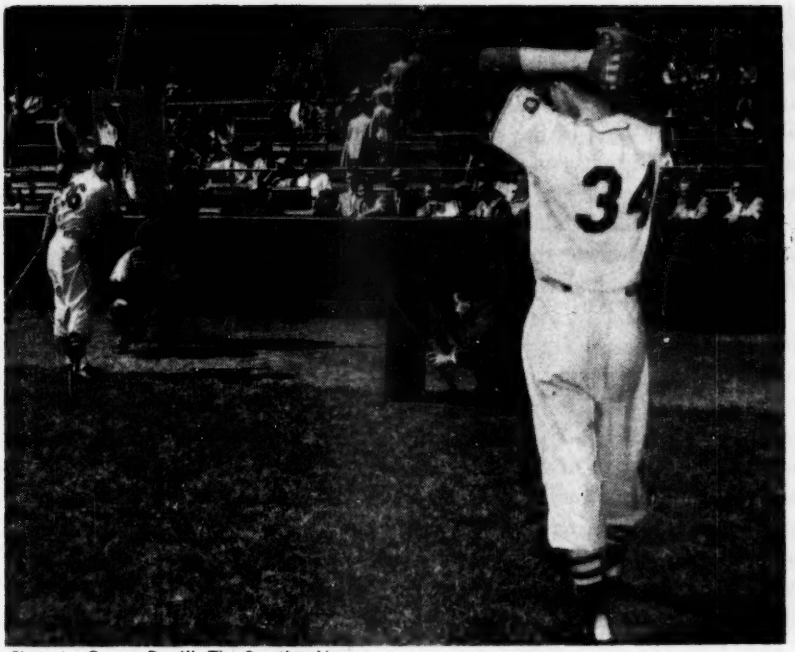

Photo by George Dorrill, The Sporting News

A. W. Hubbard holding mirror, which was actually behind batting cage when pictures were taken.

Chas. N. Seng operating movie camera, which was actually 15 or 20′ from home plate when pictures were taken.

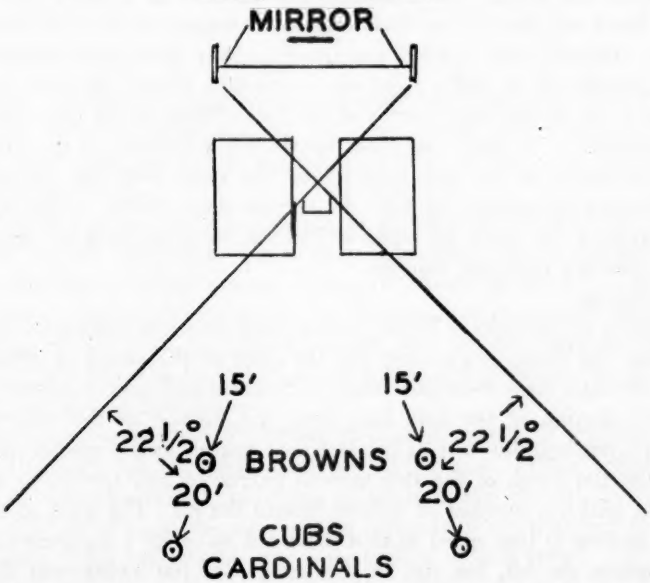

FIGURE I. Equipment and Arrangements for Cinematography of Eye Movements During Batting.

which motion of the bat toward the plate or ball was shown. Each criterion could be criticized as being essentially "late"—the step starts with preliminary weight-shifting before the lead foot comes off the ground; the fiinsh of the step could be considered as occurring before the whole foot is planted solidly, and the start of the swing should, possibly, include some preliminary movement of the bat away from the plate. However, these points were definite and determinable, and, as far as the analysis went, they were consistent. In determining these points and the succeeding eye and head movements, the projected frames were turned back and forth and compared for each item separately until both observers agreed, then the results were recorded.

4. *Head and Eye Movements.*—Head and eye movements were also determined by turning the frames back and forth until both observers agreed that movement had occurred. Head movements were separated into three categories, namely: head movement toward the plate (A), head movement away from the plate (B) and head tilted down (T). The possible effect of head movement forward during the step in producing an apparent "turn" of the head was minimized by the camera angle. Eye movements were also separated into three categories, namely: eye movement toward the plate (E), eye movement away from the plate (F) and eyes looking down or partially closed (C). Eye movements were recorded when the irises of the eye changed their relation within the socket.

The accuracy with which eye and head movements related to tracking could be determined, especially when the ball was far from the plate, could be questioned justifiably. However, the relative movement of the ball approaching the plate starts at a low rate in terms of degrees of arc, but increases rapidly near the plate. Consequently, the chances of finding determinable eye and head movements by this method increased as the ball approached the plate. Although the method was inadequate to determine movement during the first half of the ball's flight, there was little chance of missing tracking movements during the last quarter of the ball's flight where these movements would necessarily be large. In other words, the reliability of the analysis increased markedly as the ball approached the plate and was highest in the several frames preceding the hit. At a later stage in the analysis, 3x5 in. enlargements were made of eight sequences. Comparisons of these prints substantiated the previous analysis.

B. *Findings*

1. *Batting Movements.*—Table 2 shows the temporal relations of the start of the step, the finish of the step and the start of the swing at different ball speeds. Although there were individual differences and some tendency to delay the actual clearing of the lead foot from the ground as the ball speed decreased, in general, the start of the step was geared to the release of the ball. In contrast, the finish of the step seemed geared to ball speed—or tended to occur at a uniform number of frames before the hit. The start of the swing was also geared to ball speed in that it tended to occur a uniform number of frames before the hit, but not in the sense that the swing was slower for

TABLE 2

Frequency Distribution by Frames of Start and Finish of Step, and Start of Swing in Relation to Release of Ball by Pitcher (Frame 0) and Hit

A. Distribution of Start and Finish of Step

Ball Speed	Start of Step						Finish of Step					
(mph) Frame	0	1	2	3	4	5	6	7	8	9	10	
89.25	1	2	0	1	1		3	2				Hit 11
81.82	1	1	1	1	1	1	2	2				12
75.53	1	0	3	6	2	2	6	6	1	1		13
70.13		1	3	4	5	1		4	5	5		14
65.45		3	3	1	2	3	1	2	2	3	4	15
61.36			3	4	1	1		2	2	4	1	16
57.76			1	4	1	1	1		1	4	2	1	17
54.55			1	0	2						3	18

B. Distribution of Start of Swing

Ball Speed	Start of Swing											
(mph) Frame	0	1	2	3	4	5	6	7	8	9	10	
89.25							1	3	1			Hit 11
81.82							1	0	3	1		12
75.53							4	7	3			13
70.13							2	7	5			14
65.45							3	5	4			15
61.36							1	0	1	2	4	1	16
57.76							1	4	3			17
54.55							3					18

slower balls. In other words, the batter tended to start his step with the pitch, to delay the finish of the step and the start of the swing progressively as ball speed decreased, but not to alter the duration of the swing or, probably, the speed of the swing.

Table 3 shows a distribution of finish of the step and start of the swing in relation to frames before the hit. Analysis in these terms disregarded the effect of differences in ball speed. There was a strong tendncy (62/70 for complete series, and 82/96 for both) for the finish of the step to occur in the fourth, fifth, or sixth frame before the hit, and for the start of the swing (66/70 and 86/96, respectively) to occur in the third, fourth, or fifth frame before the hit, or one frame later.

The relation between the finish of the step and the start of the swing at different ball speeds for complete sequences (Table 4) showed that in two instances the bat was started before the whole foot was planted, but in 63 per cent (44/70) of the cases the start of the swing followed planting of the foot by one frame. The relationship was independent of ball speed.

TABLE 3

Distribution of Finish of Step and Start of Swing by Frames Before Hit

A. Finish of Step

Frames before hit	-8	-7	-6	-5	-4	-3	-2	-1	Hit	Total
Complete sequences	2	6	23	25	14	1				70
Incomplete sequences	2	1	3	8	8	3			1	26
Total	4	7	26	33	22	4			1	96

B. Start of Swing

Frames before hit	-8	-7	-6	-5	-4	-3	-2	-1	Hit	Total
Complete sequences	1	0	3	19	32	15				70
Incomplete sequences			3	4	10	6	3			26
Total	1	0	6	23	42	21	3			96

TABLE 4

Frames Between Finish of Step (Base) and Start of Swing at Different Ball Speeds

Total frames	11	12	13	14	15	16	17	18	Total
Ball speed (mph)	89	82	76	70	65	61	58	56	
2 before						1			1
1 before				1					1
Same	2		3			1	2		8
1 after	3	2	7	9	9	6	5	3	44
2 after		3	3	4	1		1		12
3 after			1		1	1			3
4 after					1				1
Total	5	5	14	14	12	9	8	3	70

2. *Head and Eye Movements.*—A summary of the analysis of head and eye movements from complete sequences in which a hit occurred is shown in Table 5. The subtotals to the right of each section are the sequences at that ball speed (frames between release of the ball and hit) and, as such, represent maxima for the cell frequencies. The incidences per frame in the body of the table should be interpreted as proportions (frequency/subtotal). In general, these proportions were rather small.

Head movements toward the plate (A) were relatively infrequent. When they occurred, they seemed to be more a reaction to the start of the batting movement (which tended to occur in the third, fourth, or fifth frame before the hit), rather than actual tracking movements. Head movements away from the plate, which obviously provided no assistance in tracking, were very infrequent and also seemed to be coupled with the movements of swinging. Even though head movements toward and away from the plate were recorded and it might seem that head movements toward the plate might provide some basis for tracking, these latter movements were qualitatively quite different from the head movements found with pass balls, which might presumably provide the basis for tracking. These findings confirmed the findings from observations under game conditions (above) in that head movements did not provide the basis for tracking a pitched ball when a swing occurred.

TABLE 5

Incidence of Head and Eye Movements by Frames from Complete Sequences in Relation to Flight and Speed of Ball

	Release by Pitcher																		
Frame	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
												Hit							
A	(Head turned toward plate)							3	1	2		1							
B	(Head turned away from plate)																		
E	(Eyes turned toward plate)								3	2		1	5 sequences						
F	(Eyes turned away from plate)																		
A							2		1										
B								1											
E								1	4	4		1		5					
F												1							
A									2	2		3	2						
B									1										
E							1		2	1		8	6	1	14				
F										2									
A										4		1	4	2	2				
B										1		1							
E									1	4			5	8	1	14			
F													2	1					
A									1			3	5	5	1				
B															1				
E										2		3	5	5	9	4	12		
F						(T—head tilted down)						(T)			1				
A										1			2	1	3	1			
B																2			
E										1		3	3	3	5	5		9	
F												1	1	(T)	1				
A														1	2	2	2		
B													1						
E													2	3	4	3	2		8
F														(T)		1			
A																		1	
B														1			2	1	1
E									1						1	1		1	3
F										1					(T)				
Frame	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Ball speed (mph)											89	82	76	70	65	61	58	55

Eye movements toward the plate (E in Table 5) were more frequent than head movements; but in only three instances were the proportions (cell frequencies/subtotals) .75 or better, and in only six more were they .50 or better. Considering only the last four frames in 70 sequences (280 cells), a total of nine cells with .50 or more is only about 3 per cent—a surprisingly small percentage. In terms of frames before the hit, the incidence of observed eye movements between the hit and the first frame preceding was only 7 (a proportion of .10); between the first and second frames preceding the hit there

were 34 instances (.49), and between the second and third, 33 instances (.47). Beyond this, the instances tailed off.

The above findings might be explained in either of two ways, namely: either the ball was not tracked clear up to the hit consistently with eye movements, or the method was inadequate. Previous mention was made of the fact that as the ball approached the plate, and especially near the plate, its relative movement would become greater—and the accuracy with which eye movements could be determined (if present) would increase. This might explain the rapid decrease in incidence preceding the third or fourth frame before the hit. But it would not explain the proportion of incidences below .50 of eye movements between frames 3 and 2, 2 and 1, and especially the .10 immediately preceding the hit. Consequently, the most reasonable interpretation was that the primary basis for tracking the pitched ball when a swing occurred was eye movements; but that tracking with eye movements was not continued up to the hit. Actually, when momentum for the swing is generated and applied to the bat (during the interval between the hit and, possibly, the fourth or fifth frame before the hit), the path of the swing is determined on the basis of previous estimates of the instant and position at which the ball will arrive over the plate, so further tracking would serve no useful purpose. There is also a question whether visual tracking is possible at the high relative speed of a pitched ball close to the plate.

Further evidence of the reliability of the above analysis was obtained, in part, when 3x5 in. enlargements were made of eight complete, representative sequences. These provided a better basis for analysis since comparisons could be made between frames separated by several intervening frames. Comparison of the prints showed that some slight eye movements occurred in earlier frames; but that in the case of frames closer to the hit even though incidences of eye movement were recorded where there was apparent movement from frame to frame, there was also considerable question whether the eyes were focused on the ball in the later frame.

Two of these series, with enough magnification to show primarily the eyes, are presented in Figures II and III. These both happen to have been taken at 48 frames per second so that in terms of 24 frames per second (used in the tabulation) what happened between the second frame before the hit and the hit would have been considered as happening between the first frame before and the hit. Although the point on which the eyes were focused cannot be determined with absolute certainty, Sauer (Figure II) was certainly not looking at the ball in frame 22, just before the hit, nor in frame 21, probably not in frame 20, possibly in frame 19, and probably in the preceding frames. For this sequence, an eye movement was recorded between frames 16 and 18. Diering (Figure II) was not looking at the ball in frame 29 or after, nor in 28, although the eyes moved, possibly in 27 though probably behind it, and probably in frame 26 and preceding. In both cases the previous analysis was in essential agreement.

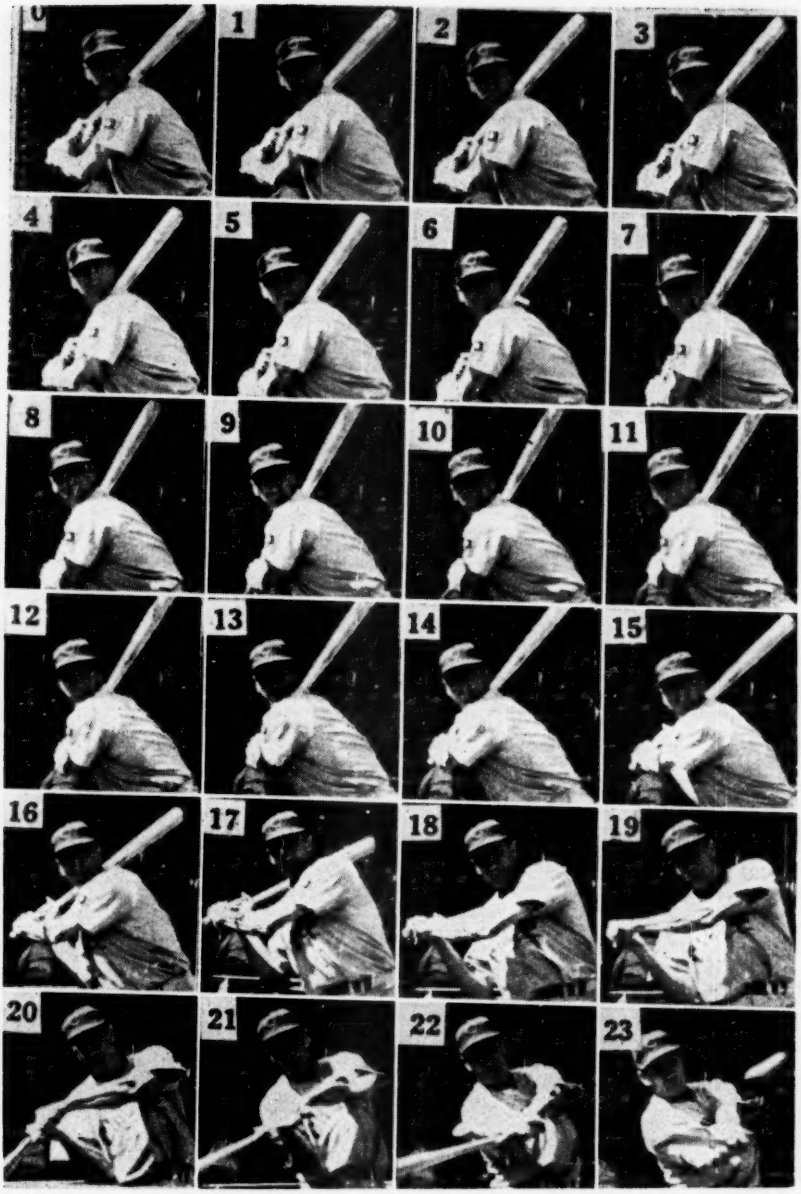

FIGURE II. Henry Sauer, Chicago Cubs, 1951 Batting Average .271. Camera Speed 48 frames per second. Ball Speed: 89 miles per hour, ca. 2.64 feet per frame.

Frame: 0—Immediately before ball was released by pitcher. 1—First frame after pitcher released ball. 4—Start of step (forward foot clear of ground). 14—Finish of step (forward foot replanted on ground). 15—Start of swing (bat in motion toward plate). 19—Head movement toward plate. 22—Head movement away from plate. 23—Head movement away from plate. NOTE: Comparison of 15 and 19 shows eye movement.

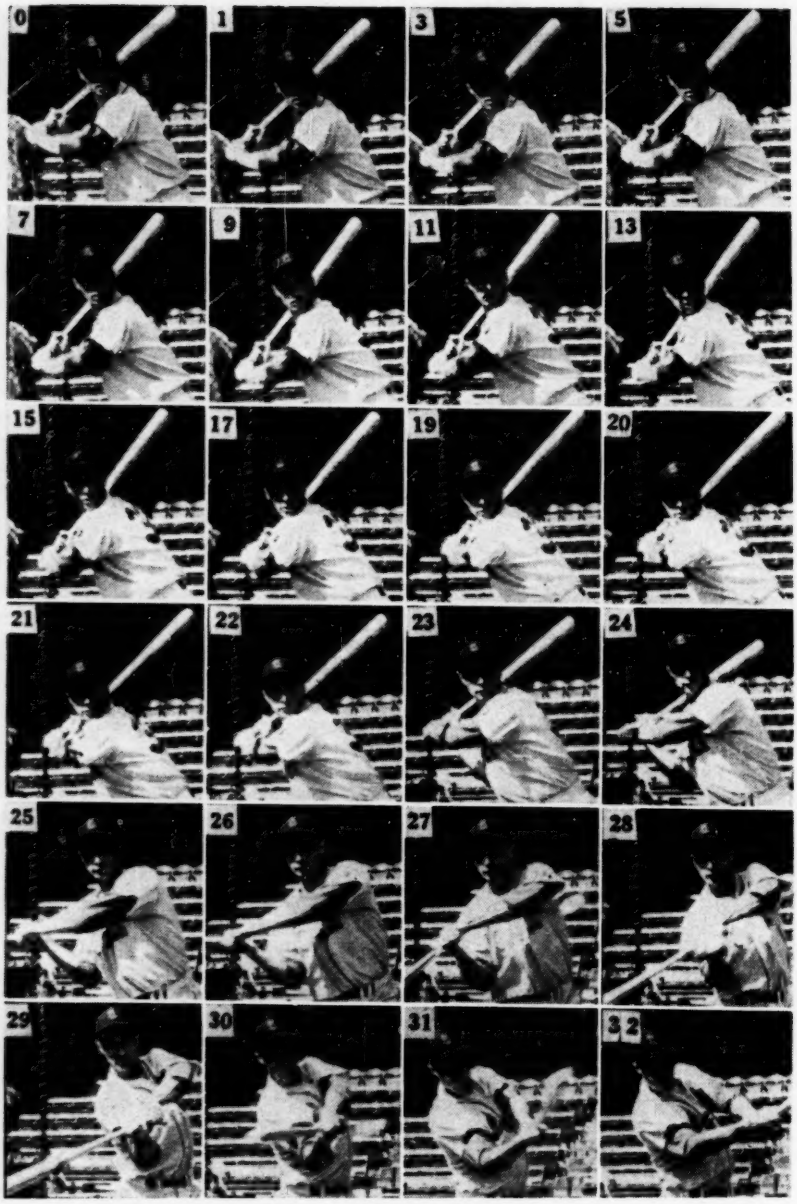

FIGURE III. Charles Diering, St. Louis Cardinals, 1951 Batting Average .252. Camera Speed: 48 frames per second. Ball Speed: 63 miles per hour, ca. 2.00 feet per frame.

Frame: 0—Immediately before ball was released by pitcher. 1—First frame after pitcher released ball. 9—Start of step (forward foot clear of ground). 22—Finish of step (forward foot replanted on ground). 23—Start of swing (bat in motion toward plate). 24—Eye movement toward plate. 25—Eye movement toward plate. 26—Eye movement toward plate. 27—Head turned slightly toward plate. 28—Head turned slightly away rom plate. Question whether eyes are tracking the ball. Eyes starting to unconverge. 29—Head turned away from plate. Eyes ixated. Eyes unconverged. 30—First frame after hit. Head turning away from plate. Eyes turned toward plate and fixated externally—compensatory movement. Eyes unconverged.

Discussion

The primary basis for tracking pitched balls when a swing occurred—in contrast to watching them cross the plate by turning the head—seemed to be eye movements. However, these eye movements did not appear to continue up to the point of ball contact with the bat. Either the tracking was broken off at some point beyond which additional information would have been superfluous since the bat was on its way, or the tracking was broken off because the visual apparatus broke down—was incapable of tracking at the very high relative velocity of a pitched ball near the plate—or both.

Although opposed to what is considered good form in batting, the first alternative amounts to the same thing as the finding of Barnes et al. (2) that skilled factory workers in tasks requiring visual guidance nevertheless took their eyes off their work .06 to .24 seconds before the act was completed. At some point, further perception provides no further useful information for controlling the motor response; when the swing is well under way further tracking would be superfluous. However, this does not mean that in teaching beginners or in coaching batters one should minimize the importance of tracking the ball as long as possible. It is probably better to emphasize tracking the ball up to the hit—knowing that it is not necessahry and perhaps impossible—rather than to tell them that it is impossible and unnecessary and run the risk of having them not track the ball as long as possible.

The question of whether human visual apparatus is capable of tracking at the very high relative angular velocity of a pitched ball near the plate depend on the type of eye movements involved and maximum possible rate of these movements *with* perception—not only moving the eyes but also seeing. There was no direct evidence as to whether pursuit movements or saccadic jerks—quick jumps from one fixation point to another—were used in tracking. However, Dodge and Cline (9) found that in saccadic jerks the duration for 5° movement was 0.029 second and for 15°, 0.048 second. At a camera speed of 48 frames per second, there would be about .02 second between frames and the exposure time was about a third of this, or .007 second.

If saccadic jerks had occurred, there would have been a good chance of having some frames during which the eye was moving rapidly—resulting in a blurred image. None was found. In contrast, the eyes seemed to move smoothly at a progressive rate. Also, the duration of the fixation phase between saccadic jerks in reading is seldom less than 0.2 second—during which time the ball would travel about 18 feet at 60 miles per hour or 26 feet at 90 miles per hour. On the basis of indirect evidence and certain parameters of saccadic jerks, it seemed doubtful that the basis of perception in batting resembled that in reading.

Since pursuit movements of the eyes seemed to provide the basis for tracking, there was a question whether pursuit movements with perception were possible at the relatively high angular velocities of a pitched ball near the plate. As Woodworth stated, "*For distinct vision, the image of the object*

must be stationary on the retina" (17). Pursuit movements of the eyes have been considered quite slow, but no determination of their maximum rate was found. Presumably they could be no faster than saccadic jerks, which Dodge and Cline found to have durations of 0.1 second for 40° movement, or 400° per second (9). Although this seems extremely high, pitched balls near the plate actually have rates considerably higher. Consequently, it seems highly improbable that either pursuit movements or saccadic jerks by themselves provide an adequate basis for tracking the ball to the plate. This may explain why, when a batter wishes to track a ball to the plate rather than swing, he turns his head.

Skilled batters (Ted Williams and Rogers Hornsby) have stated that they saw the bat contact the ball—the inference being that *all* pitched balls were tracked to contact, that their visual equipment was distinctly superior, and that failure to see the ball contact the bat indicated either defective vision or form. Although we found no evidence that the eyes were focused on the ball at contact in the sample studied, and although it seems unlikely that all balls could be tracked to contact, there might be very special circumstances under which it would be possible to track the ball to contact on *certain* pitches. Another possible explanation would be that accurate prediction of the ball's path and sensory cues from bat contact might be merged to form an illusion of "seeing" the ball hit and "knowing" where it would go. Bunting is, of course, a special case. Human perception customarily bridges gaps in sensory information and merges stimuli from diverse modalities to an unitary impression.

Convergence would be expected with an approaching object. No direct evidence of convergence was found, but if one compares frames 26 and 27 in Figure III (Diering) with Frames 29 and 30 there is evidence of *un*convergence; the eyes appear to change from near to distant focus, and frame 28 shows them in between. Frames 29 through 32 also showed a compensatory movements of the eyes as the eyes maintained an external fixation point while the head turned. Some compensatory eye movements were also noted when the head turned during the wind-up for the swing and the eyes compensated.

Summary and Conclusions

Electromyography, observation under game conditions, analysis of published photographs and cinematography were used to study the visual-perceptual basis for batters tracking pitched ball. Forty-two university and 59 professional players were observed in games and 29 professional players were photographed in batting practice, with ball speeds between 55 and 89 miles per hour. On the basis of the subsequent analysis and considering the limitations of each method, the following conclusions seemed justified.

1. Watching the ball cross the plate without swinging often involved tracking movements of the head; the head was turned either with the passage of the ball, or subsequent to it, or not at all.

2. Visual tracking when a swing occurred was accomplished with the head essentially fixated and the eyes moving. Pursuit movements of the

eyes seemed to provide the primary basis for tracking. Convergence and compensatory movements were also found, but no evidence of saccadic jerks was found.

3. The ball was not tracked with eye movements clear up to bat contact. An explanation of why tracking to contact might be impossible, unnecessary, or both, was given. Under special circumstances tracking to contact may be possible. However, parameters in vision and ball movement suggest strongly that reports of ability to track to contact are based on an illusion resulting from perceptual integration of diverse sensory stimuli.

4. On the motor side, professional batters at ball speeds between 55 and 89 miles per hour geared the start of the step to the release of the ball by the pitcher. The duration of the step and the start of the swing, however, were geared to ball speed—starting later for slower pitches. The start of the swing was closely related to the finish of the step and tended strongly to occur one frame (about .04 second) after the forward foot was planted firmly. Irrespective of ball speed, the swing tended to have relatively uniform duration.

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(Submitted 7-7-53)

Teacher Needs in Health Education

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Abstract

This study growing out of a need for evaluation of the Health Department's participation in teacher health education programs, reports the health education knowledge level, interests, and needs of teachers and high school pupils as revealed by a specific testing instrument. No statistically significant difference was noted in the score made by classroom teachers and supervisors, both ranking ninth-grade level. Pupils ranked seventh-grade. Needs of teachers related to basic health information, improved environmental sanitation, guidance in the intelligent use of community resources and health education materials, the application of screening techniques, and methodology.

THE STATUS of health education in teacher education colleges, and the responsibilities of these institutions in the preparation of teachers in the area of health, have been problems subjected to critical examination in recent studies (1, 3, 7, 9). It is generally agreed that these colleges, in particular, are increasingly facing the responsibility of providing experiences in health education growing out of the needs and interests of teachers in service and of prospective teachers. There is a voluminous literature pointing up needs of teachers in health education. Specific broad areas of experiences have been set up as guides for the development of functional curriculums (1, 3, 8, 9).

In an effort to determine teacher needs and interests in health education, a study was undertaken in certain randomly selected counties in Georgia.[1] The sample consisted of 127 persons in ten counties comprising 49 classroom teachers, 50 senior-high-school pupils, and 25 supervising teachers.

Purpose of the Study

The expressed purposes of this study are: 1. to determine the health education knowledge level of classroom and supervising teachers as revealed by a specific instrument; 2. to similarly ascertain the health education knowledge level of senior-high-school pupils; 3. to discover certain felt needs of teachers in the area of health education; 4. to ascertain teacher and pupil needs in health education as revealed by the instrument; 5. to relate these discovered needs to the health department's participation in the teacher health education program, particularly in summer-school college health classes and workshops (7). It was hoped also that such facts as were revealed by the test might stimulate colleges in the state to re-evaluate their curriculum in health in the light of test results (6).

The instrument used was the "Health Education Test—Knowledge and Application (Grades 7-12 and College), Acorn National Achievement Tests for

[1]The writer acknowledges the invaluable assistance and guidance of Henry B. Wells in Statistical Research, and the untiring efforts of Mrs. A. Cathryn Johnson, health educator, and other members of the staff of the Georgia Department of Public Health.

secondary schools and colleges."[2] It consists of 100 multiple-choice and true-false items. The 60 multiple-choice items deal with important facts and concepts. The remaining 40 true-false items apply health knowledge through subject reactions to problem situations. The following categories are covered by the instrument; Food and Nutrition; Mental Aspects of Health; Health in Home, School, Community; Safety and First Aid.

Procedure

Ten counties were selected at random, and from each of these counties, five classroom teachers were randomly selected. There were 49[3] classroom teachers tested.

The supervising teachers hold undergraduate college degrees and receive in addition highly specialized postgraduate training in supervision, including special emphasis in health education. Twenty-five of these supervisors were randomly selected.

A random sample of ten high schools was chosen from the list of accredited high schools in the state. From the roll of each of these high schools so chosen, a random selection was made of ten seniors. Ages ranged from 14-23, with a mean age of 16.7. These pupils were tested at the school during the regular school day. Classroom teachers and supervisors were tested in groups at designated places, usually a school, centrally located. All tests were given by a health educator from the State Health Department, Division of Public Health Education.

In addition to the testing instrument, questionnaires were submitted to all teachers, recording age, marital status, degrees held, data related to individual preparation for teaching health, and specific felt needs of the teacher in the area of health. Further, each teacher was asked to write briefly her concept of health education.

Analysis of Data

Sex and Age Distribution. Of the 49 classroom teachers, 9 were males, 40 females. The ages ranged from 22 to 66 years. Age distribution is shown in Table 1.

TABLE 1

Age Distribution of Classroom Teachers

Age	Per cent
Under 30	38.7
Under 40	73.3
Over 40	26.5
22-25	32.5
26-38	37.0
39-49	20.4
50-60	8.1
Over 60	2.0

[2]This test was constructed by Dr. John H. Shaw, and Dr. Maurice E. Troyer of Syracuse University, and edited by Dr. Clifford L. Brownell, Columbia University.

[3]One teacher did not report for the test.

Preparation for Teacher Health Education. Twenty-seven teachers held college degrees; the remaining 22 had from one to three years' college work. Teaching experience ranged from one year to 35 years. Eighteen had been exposed to college courses in health education or related subjects. Of these, three gave only summer workshop experiences. Fourteen listed at least one or more college courses in health education. Five of the 14 who reported courses in health education received them on the graduate level.

These courses in health education and related subjects reported by teachers varied widely in content, philosophy and objectives, methodology, credits earned, number of class hours, requirement in the college curriculum, and in course nomenclature. Marked variation was evident also in interest and direction in health education at the college administrative level. Similar findings have been reported by other investigators (3, 10).

Test Results

The average percentage of correct response ran parallel in all groups; highest scores being attained in Mental Health; lowest scores in Safety and First Aid, except that for pupils, lowest percentage correct responses was in Health in Home, School, and Community. Average correct response for each category is shown in Table 2.

TABLE 2

Subject Matter Categories: Gross Average Scores for Teachers, Supervisors, Pupils

Category	Number of questions	Average P. C. R.		
		Supervisors	Teachers	Pupils
Mental Health	26	72.3	62.3	48.7
Health in Home, School, Community	49	58.1	57.9	34.5
Food and Nutrition	28	53.6	55.0	45.0
Safety and First Aid	26	53.5	49.6	39.5

Health Knowledge and Health Application. Considering the number of test items, the total possible scores were as follows: Health Knowledge (Part 1), 60; Health Application (Part 2), 40; total test (Part 1 & 2), 100. Table 3 shows the average scores earned by those tested. Results are shown graphically in Figures I and II.

TABLE 3

Average Test Scores—Supervisors, Teachers, Pupils

Area	Supervisors	Teachers	Pupils
Health Knowledge	36.09	32.02	23.86
Health Application	24.91	23.30	19.76
Test Total	61.00	55.32	43.62

On the test as a whole, no appreciable difference was shown in the scores made by high-school girls and boys, in spite of the fact that in practically all of the high schools tested there were well-organized classes in homemaking for girls.

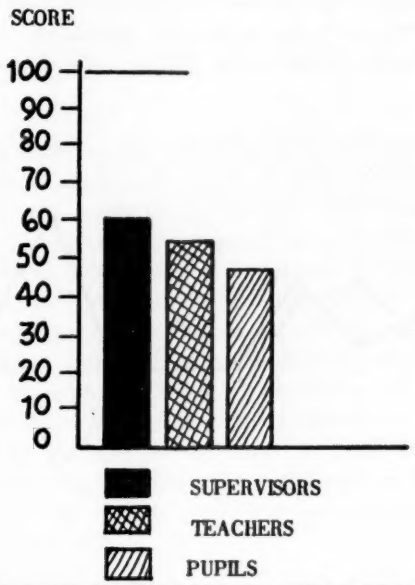

FIGURE. I. Comparison Average Total Scores with Maximum Obtainable Score—Supervisors, Teachers, Pupils

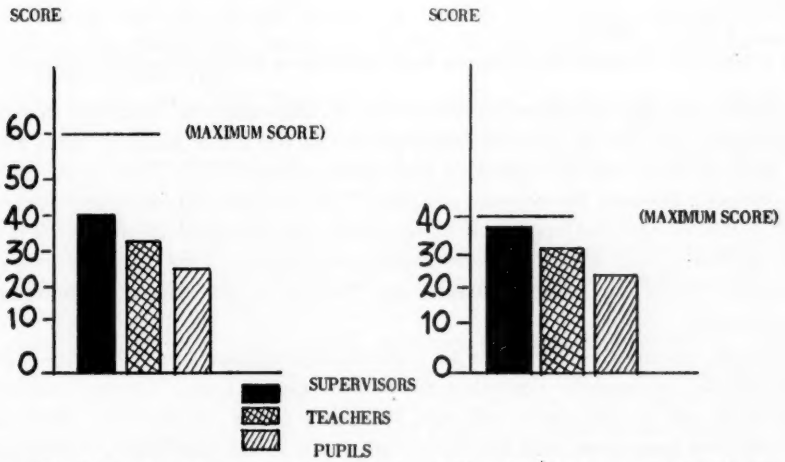

FIGURE II. Comparison Average Score—Part I and II—with Maximum Obtainable Score, Supervisors, Teachers, Pupils

Average Pupil Score	43.62
Average Boys' Score	43.65
Average Girls' Score	43.55

However, there was a wide fluctuation in both boys' and girls' scores as related to the individual high schools tested. This is shown in Figure III.

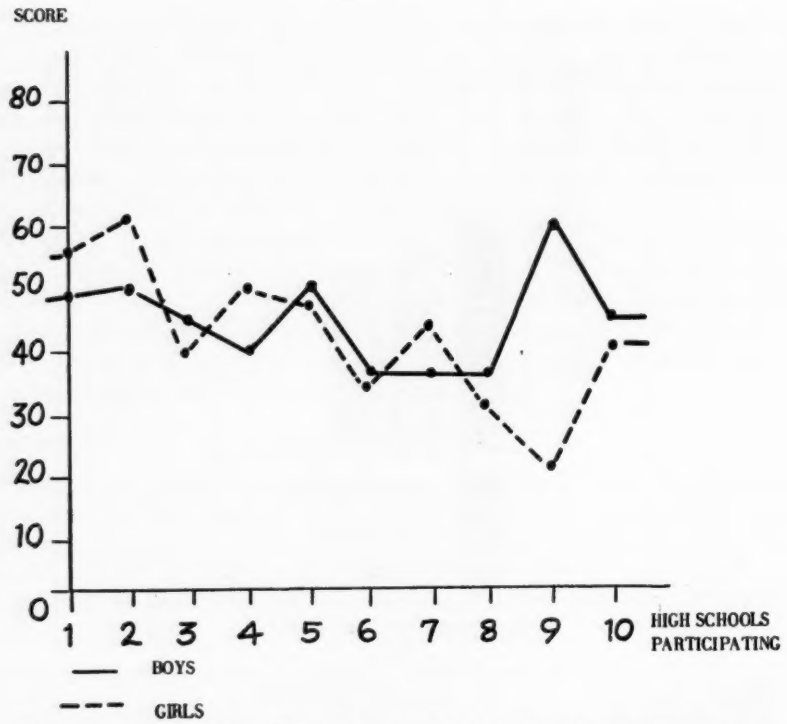

FIGURE III.—Comparison of Scores, Boys and Girls in Participating High Schools

There was also a noticeable fluctuation in sub-scores of teachers in counties tested, and also in the total average scores, the latter ranging from a low of 55.4 to 86.3, out of a possible maximum score of 129. The apparent inconsistency between the sub-score total of 129 and the maximum test score of 100 is due to the overlapping of questions in the sub-score areas, i.e., a number of items include two or more facts in the table. One item for example includes Nutrition, Mental Health, and Health in the Home, School, and Community.

Age of teachers tested seems to exert some influence on the score—older individuals apparently contributing lower scores than younger teachers. Teachers and pupils ranked 9th and 7th grade levels, respectively, when test scores were compared with the norms set forth in the manual of instructions for the test. There was no significant difference between the scores made by classroom teachers and supervisors.

Teacher Felt Needs. As revealed by the questionnaire, the following felt needs are emphasized:

1. Specific problems involved in teaching health such as: Poor environmental sanitation in schools and community, and poor equipment in schools.

2. Personal needs specified more information about health education, particularly use of community resources, screening methods, group dynamics, basic health information, use of health education materials.

Summary

An analysis of data indicates the following to be the findings: In terms of this specific test, teachers ranked 9th grade level, pupils 7th grade level, respectively. There is a wide variation in teachers' understanding of the term "health education" as revealed by answers from a questionnaire submitted to teachers taking the test. Felt needs as expressed by both supervisors and classroom teachers do not differ materially. They include basic health information, improved environmental sanitation in schools and community, improved school equipment, information on intelligent use of community resources, training in screening techniques, knowledge of group dynamics, methodology, and use of health education materials.

Needs as revealed by the specific test relate to basic health information, particularly in the areas of Safety, First Aid, and Health in Home, School, and Community, Highest scores in this study are recorded in Mental Health; lowest, in Safety and First Aid.

Conclusion

While it is obvious that further investigation along the above lines is desirable, this study nevertheless reveals that:

1. Both in high school and in teacher education colleges more emphasis should be placed on: Safety and First Aid, Nutrition, Health in Home, School, Community.

Studies by Hinrichs (5), Hancock (4), and an examination of 318 in-service teachers by Blanchette (2), using Hancock's list of 100 science misconceptions, further emphasizes the need for implementation of high school and college curriculums in the area of health.

2. Teacher education colleges should set up plans for implementing in-service training of teachers in health education. Curriculums growing out of such planning should take into consideration teacher needs as revealed by the findings of this study.
3. Resource persons from health agencies working co-operatively with teacher education colleges in the in-service training of teachers should be selected on the basis of specific contributions which such persons can offer in the area of teacher needs in health education as reflected by this study.

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(Submitted 6-24-53)

Influence of Exercises, Emotional Stress, and Age on Static Neuromuscular Tremor Magnitude

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Abstract

Data were collected from 90 subjects to show the effect of graded bouts of different exercises on neuromuscular tremor magnitude. It was found that tremor magnitude varied directly with the strenuousness of exercise. Data were collected from 15 students before and after a written examination to show the effect of emotional stress on neuromuscular tremor magnitude. The stress precipitated by the examination significantly increased neuromuscular tremor magnitude. A comparison of neuromuscular tremor magnitude of young boys with that of elderly men showed that the men had a significantly greater neuromuscular tremor magnitude than the boys.

ACCORDING TO Sollenberger (9) neuromuscular tremor in healthy individuals has been recognized since 1886. Since that time experimentation has been carried on concerning this neuromuscular response. However, until the advent of electronic devices, instrumentation conducive to accurate and convenient measurements was not available.

Although neuromuscular tremor in man is recognized as a normal physiologic phenomenon, it is regarded clinically as being altered by pathologic changes in the nervous system. In order to clarify various types of normal tremor in man, Bucy (4) describes three types, namely, (a) tremor at rest, that is, that tremor which occurs in parts of the body which are supported but which are not, at the time, involved in muscular contraction; (b) intention tremor, also known as action tremor, which occurs in musculature which is being voluntarily contracted, and (c) static tremor which is a manifestation of intention tremor but which is exhibited by a member of the body which is being held still and unsupported except by voluntary resistance against the force of gravity. The experiment herein reported[1] is an investigation of static neuromuscular tremor only.

It is generally recognized that static neuromuscular tremor is the result of rhythmic tonic changes in antagonistic muscles, due to the rhythmic discharge of weak impulses from the anterior horn cells. It has been observed that the extremities of all normal people exhibit neuromuscular tremor in the static state. It follows that only those individuals whose muscles have been denervated either by an interruption of the motor nerve or by an anterior horn cell lesion have no neuromuscular tremor.

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[1]This research was supported in part by a grant from the Cereal Institute, Inc., Chicago, Illinois. The study was made in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate College, State University of Iowa. Dr. Mitchem is Professor of Physical Education at Prairie View Agricultural and Mechanical College, Prairie View, Texas.

Although neuromuscular tremor has no apparent physiologic purpose, it has been shown to be a sensitive measure of the effects of stress on physiologic responses. In fact, this physiologic phenomenon makes for unsteady behavior of the extremities and calls forth compensation for a lack of steady response. Hence, neuromuscular tremor, and factors which influence its magnitude, become important to physical education, for steadiness is regarded as essential in certain skill performances.

From the above discussion, it would seem that since it is impossible to maintain the muscles of the body in a state of steadiness, compensation for this unsteady state might be gained only through experience and practice. Furthermore, any change in the environment or in the nervous system which augments tremor puts additional demands on the compensatory mechanism. Emotional stress and fatigue are the chief factors that augment tremor in normal individuals. To avoid emotional stress, or to overcome emotional reactions, would appear to favor steady performance even in highly trained performers. It must be recognized, however, that normal individuals should learn to compensate for neuromuscular tremor.

Review of Literature

Eshner (5), in 1897, reported an investigation involving both normal and pathologic subjects in order to determine whether certain pathologic states resulted in neuromuscular tremor which show distinguishing characteristics. For these purposes, an instrument designated as a tremograph was employed. In over one hundred normal and pathologic cases, all the normal subjects demonstrated neuromuscular tremor, although some of the pathologic cases failed to show this phenomenon. The mean neuromuscular tremor rate was 6.7 tremors per second, the fastest rate being 10.7 per second. The neuromuscular tremor movements were found to be irregular in rhythm and in amplitude, and the frequency and the amplitude to be inversely related.

Wolfenden and Williams (17) were the first to make well-controlled systematic records of neuromuscular tremor. Their investigation was designed to determine whether there was any difference between normal tremor rate and the rate accompanying Grave's disease, paralysis agitans and lateral sclerosis. The data which they presented showed that tremor rate accompanying these diseases was no different than that in normal cases.

The studies of neuromuscular tremor that have been reported have dealt with, in addition to pathologic implications, the character, the origin, the classification, and the influencing factors of this phenomenon. Binet (2), in an attempt to classify the factors influencing tremor, proposed what he called the laws of tremor. The laws are as follows: (a) Tremor calls forth tremor. This was interpreted to mean that if a record is taken of the normal tremor and then an order is given to execute tremor voluntarily, the subject initiates a pattern of intention tremor which is entirely different from the pattern of the normal tremor. (b) Tremor increases as a result of muscular contraction and becomes exaggerated as a result of work. (c) Tremor is exaggerated by

emotional stress. (d) Tremor may be modified by respiration. (e) Tremor is exaggerated by cold. (f) Tremor is modified by peripheral impressions.

The origin of tremor has been studied by a number of investigators (1, 6, 8, 9, 10). The conclusion drawn is that tremor is a result of postural contraction inherent in the simplest reflex arc, and that it is independent of the higher centers as to origin, although it is modified by their activity. The rate at which tremor occurs has been studied by Herren (7) and Bousfield (3), who concluded that for the upper extremity the rate varies from 5 to 12 per second, the reason for the upper limit being that the upper limit of anterior-horn-cell discharge is 12 impulses per second.

In most of the investigations reported, tremor has been considered from the standpoint of rate and amplitude change. Recently Tuttle and co-workers (12) have devised equipment by which tremor can be recorded electronically. In place of considering tremor from the standpoint of rate and amplitude these investigators have combined these two elements of neuromuscular tremor response into what they call neuromuscular tremor magnitude.

Tuttle and co-workers (11, 13, 14) have made extensive use of the electronic technique in studying the effects of altered breakfast habits on neuromuscular tremor magnitude. These investigators found that the omission of breakfast resulted in sufficient stress to cause an increase in neuromuscular tremor magnitude.

Tuttle and co-workers (12) reported an experiment which has a direct bearing on the present investigation. They showed that on the basis of stool-stepping exercises, the mean tremor magnitudes of 21 subjects increased as the strenuousness of the exercises was increased.

The primary purpose of the study reported here was to show the effects of exercises of graded intensity on the static neuromuscular tremor magnitude. In addition, the effects of emotional stress and age on static neuromuscular tremor magnitude were investigated.

Procedure

Static tremor was recorded from the index finger of the outstretched arm which was supported by voluntary resistance against the force of gravity. The index finger barely touched the activating pin of a Statham strain gauge (Model GI-8-130), which was supported on a ring stand, and adjusted so that when the index finger touched the strain gauge pin the outstretched arm was approximately at a 60° angle to the trunk. This particular gauge consists of four fine wires, the arrangement of which is shown schematically in Figure I.

An input of 5 volts is applied and a current of 0.04 ampere is continuously passing through the gauge. The resistance of each pair of wires is balanced so that there is zero potential difference between the output terminals. The arrangement is a Wheatstone bridge. If pressure is applied to the activating pin, there is a tension change in each pair of wires and an unbalanced bridge is created. The movement of the extremity touching the pin of the gauge un-

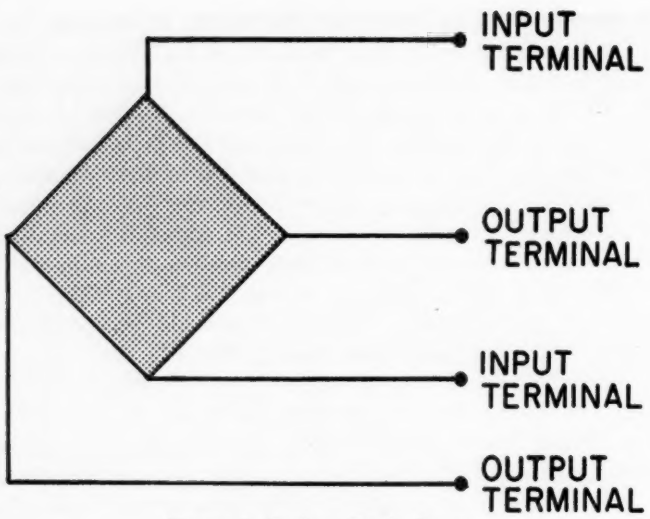

FIGURE I. Statham Strain Gauge.

balances the bridge alternately on both sides, thus producing an alternating change in voltage in the output. The voltage thus generated is amplified by a Brush amplifier so that it can be recorded on a Brush recorder.

The instrument is standardized by introducing a fixed resistor in parallel with one leg of the strain-gauge bridge. The gain of the amplifier is adjusted so that switching in this resistor produces a deflection on the recorder chart. This standardization may be varied so that small tremor amplitudes can be magnified to facilitate measurement and large tremor amplitudes can be reduced so that they will be within the range of the recorder. So that all tremor amplitudes are comparable, each record of tremor is changed to a common standardization value. In this experiment the standard deflection was 2 cm.

The tremor magnitude was calculated as follows: Beginning at a "trough" anywhere on a record, exactly 125 mm. were laid off by ordinates, then lines were drawn from trough to trough (see Figure II). Since the recording paper

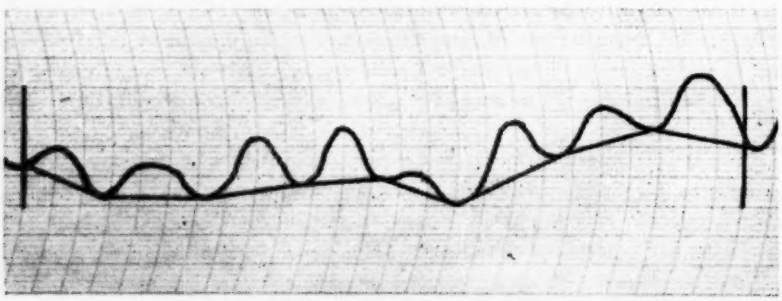

FIGURE II. A Record of Neuromuscular Tremor.

speed was 125 mm. per second, this provides a tremor record of one second's duration. By means of a planimeter, the areas under the curves were measured five times, the average being used as tremor magnitude. If a record ended at some fractional part of a tremor, only that part of the record bounded by the base line, the tremor lines, and the ordinate was measured. The result of this approach is that tremor rate and amplitude are combined, and expressed as neuromuscular tremor magnitude. The procedures involving each individual experiment dealing with neuromuscular tremor magnitude are described later.

For the purpose of establishing the reliability of the measurements of neurosmuscular tremor magnitude, three experiments were carried out as follows:

(a) Each of 16 subjects made a record of neuromuscular tremor, then allowed the arm to fall to the side. Immediately, a second record of neuromuscular tremor was recorded. The neuromuscular tremor magnitudes for the two sets of records were correlated. The coefficient of correlation was 0.796.

(b) To further demonstrate the reliability of the method for measuring neuromuscular tremor magniture, 16 subjects recorded neuromuscular tremor, after rest, for periods varying from four to six seconds, on two occasions which were from one to two days apart. The records were made at approximately the same time each day. The mean neuromuscular tremor magnitude per second was calculated for each subject for each day. The two sets of neuromuscular tremor magnitudes were correlated. The coefficient of correlation was found to be 0.951.

(c) In a third experiment relative to the reliability of measurement of neuromuscular tremor magnitude, two records of neuromuscular tremor were made for 14 subjects on two different days following an exercise in which the subjects performed ten arm curls with 15-lb. weights at the rate of one curl per second. The magnitudes for each set of records were calculated and correlated. The coefficient of correlation was 0.583.

Analysis of the Data

1. *Arm curls.* This experiment dealing with arm curls involved 30 subjects, 16 males and 14 females, between the ages of 16 and 66 years. Each subject came to the laboratory and rested for ten minutes in a supine position on a hospital cot. At the end of the rest period, the subject stood erect and recorded his neuromuscular tremor as previously described. Immediately following the recording of the neuromuscular tremor, the subject performed ten arm curls per bout in successive bouts with 5-, 10-, and 15-lb. weights at the rate of one curl per second. Immediately following each exercise bout, the neuromuscular tremor was again recorded.

The mean data relative to the effect of bouts of arm curls of graded intensity on neuromuscular tremor magnitude are shown and compared in Table 1. The data show that, on the basis of the means, there was, except in one instance, a significant increase in neuromuscular tremor magnitude as

the intensity of the exercise was increased. Although the five-pound curls caused an increase in the neuromuscular tremor magnitude the increase was significant only at the 10-per-cent (9.98) level of confidence.

2. *Knee-bending.* This experiment involved 30 subjects, 20 males and 10 females between the ages of 18 and 37 years. The general laboratory procedure was the same as that described in 1. In doing the knee-bends, each subject was instructed to stand with one foot forward and to place the hands on the hips. From this position, complete knee-bends were performed at the rate of one knee-bend per second. Four bouts were performed by each subject, that is, 5, 10, 15, and 20 knee-bends. The neuromuscular tremor was recorded after rest as previously described, and after each bout of knee-bends.

The mean data showing the effect of bouts of knee-bending exercises of graded intensity on neuromuscular tremor magnitude are presented and compared in Table 2. The data show that, on the basis of the means, the neuro-

TABLE 1

Effect of Arm Curls of Graded Intensity on Neuromuscular Tremor Magnitude

	Neuromuscular tremor magnitude (in sq. cm.) after			
	Rest	5-lb. curls	10-lb. curls	15-lb. curls
Mean	1.62	1.96	2.37	2.69
S.D.	0.63	1.11	1.09	1.23

	t	Significance level
		%
Rest vs. 5-lb. curls	1.65	9.98
Rest vs. 10-lb. curls	3.68	0.09
Rest vs. 15-lb. curls	4.71	0.01
5-lb. vs. 10-lb. curls	3.60	0.12
5-lb. vs. 15-lb. curls	4.06	0.03
10-lb. vs. 15-lb. curls	2.08	4.46

TABLE 2

Effect of Knee-Bending of Graded Intensity on Neuromuscular Tremor Magnitude

	Neuromuscular tremor magnitude (in sq. cm.) after				
	Rest	5 knee-bends	10 knee-bends	15 knee-bends	20 knee-bends
Mean	1.07	1.24	1.35	1.58	1.93
S.D.	0.32	0.32	0.46	0.49	0.74

	t	Significance level
		%
Rest vs. 5 knee-bends	2.29	2.88
Rest vs. 10 knee-bends	3.09	0.43
Rest vs. 15 knee-bends	5.13	0.00
Rest vs. 20 knee-bends	6.23	0.00
5 vs. 10 knee-bends	1.21	24.01
5 vs. 15 knee-bends	4.66	0.01
5 vs. 20 knee-bends	5.52	0.00
10 vs. 15 knee-bends	3.23	0.33
10 vs. 20 knee-bends	5.09	0.00
15 vs. 20 knee-bends	4.23	0.02

muscular tremor magnitude varied directly with the number of knee-bends in each bout of exercise. All the differences, except the difference between the bouts of 5 and 10 knee-bends, were significant.

3. *Bicycle riding.* Because the arm curls involved chiefly the arms and the knee-bending involved chiefly the legs, bicycle riding in which the subjects were required to stand while riding with maximum effort was included, since this exercise causes great stress on the entire body. The construction, calibration, and the use of the bicycle ergometer have been described by Tuttle and Wendler (16).

The bicycle experiment involved 30 men, aged 17 to 30 years. The general experimental procedure was the same as that described in 1 and in 2. Immediately following the recording of neuromuscular tremor after rest, each subject did 720 Kg-m. of work in one minute on the bicycle ergometer, after which the neuromuscular tremor was again recorded. This procedure was repeated with the subjects doing 1,250 Kg-m. of work in one minute, 1,930 Kg-m. for one minute, followed by a one-minute ride of maximum effort. In addition, the amount of work done during the period of maximum effort was correlated with the neuromuscular tremor magnitude resulting from the work.

The mean data showing the effect of bouts of bicycle riding of different intensities on neuromuscular tremor magnitude are shown and compared in Table 3. The data show that the magnitude of neuromuscular tremor varied directly with the intensity of the bouts of bicycle riding. The fact that the difference between the neuromuscular tremor magnitude following the 720 Kg-m. of work in one minute and that following the 1,250 Kg-m. of work in one minute was not significant suggests that the intensity of these two bouts of exercise was not sufficiently different to cause a significant difference in

TABLE 3

Effect of Bicycle Riding of Graded Intensities on Neuromuscular Tremor Magnitude

	Neuromuscular tremor magnitude (in sq. cm.) after					
	Rest	720 Kg-m. in 1 min.	1250 Kg-m. in 1 min.	1930 Kg-m. in 1 min.	Maximum effort	Maximum work output Kg-m. in 1 min.
Mean	2.02	2.82	3.04	3.38	4.35	2829
S.D.	0.73	1.05	1.17	1.11	1.40	501

	t	Significance level
		%
Rest vs. 720 Kg-m. work[1]	5.13	0.00
Rest vs. 1250 Kg-m. work	5.31	0.00
Rest vs. 1930 Kgm. work	8.40	0.00
Rest vs. maximum effort	8.93	0.00
720 Kg-m. vs. 1250 Kg-m. work	1.04	32.56
720 Kg-m. vs. 1930 Kg-m. work	3.22	0.33
720 Kg-m. vs. maximum effort	5.56	0.00
1250 Kg-m. vs. 1930 Kg-m. work	1.92	6.74
1250 Kg-m. vs. maximum effort	4.60	0.01
1930 Kg-m. vs. maximum effort	3.80	0.07

[1]Each work period lasted for exactly one minute.

neuromuscular tremor magnitude. A coefficient of correlation of 0.043 was obtained between the maximum work output and the neuromuscular tremor magnitude after that work output.

4. *Emotional stress.* Fifteen Sophomore dental students served as subjects. The procedure was as follows: During the hour previous to a final written examination, the neuromuscular tremor of each subject was recorded. At a later date, the neuromuscular tremors of the same group of subjects were recorded during a regular laboratory period.

The mean data relative to the effect of emotional stress on neuromuscular tremor magnitude are presented and compared in Table 4. The data show that the mean neuromuscular tremor magnitude just before a written examination was 1.6 times greater than the mean neuromuscular tremor magnitude just before a regular class period. The data show that emotional stress caused by anticipating a written examination resulted in a significant increase in neuromuscular tremor magnitude.

TABLE 4

Effect of Emotional Stress on Neuromuscular Tremor Magnitude

	Neuromuscular tremor magnitude (in sq. cm.) before regular class period		before examination
Mean	1.39		2.17
S.D.	0.53		0.68
t		3.91	
Significance level %		0.16	

5. *Age.* Tuttle and co-workers (14, 15) have demonstrated that people in the later years of life have greater neuromuscular tremor magnitudes than younger age groups. In order to clarify the relationship of neuromuscular tremor magnitude to age, the neuromuscular tremor magnitude of a group of 26 school boys between the ages of 12 and 14 years was compared with the neuromuscular tremor magnitude of a group of 10 men between the ages of 60 and 83 years. During the experiment records of neuromuscular tremor magnitude were obtained twice each week from each subject for as long a time as the subjects were available.

The number of records secured from the younger group varied from 7 to 45 for each subject, and from the older group 19 to 40 for each subject. The general procedure for securing the records was the same as that previously described; that is, each subject rested for ten minutes and immediately following the rest period the neuromuscular tremor records were made.

Data collected showing the relation of neuromuscular tremor magnitude to age are presented in Table 5. The data show that, on the basis of the means, the men who were 60 to 83 years of age had a neuromuscular tremor magnitude that was almost twice (1.96) as great as that of the school boys in the 12 to 14-year old age group.

TABLE 5

Relation of Neuromuscular Tremor Magnitude to Age

	Neuromuscular tremor magnitude (in sq. cm.)	
	12-14 year-old boys	60-83 year-old men
Mean	2.01	3.95
S.D.	0.52	1.58
t	5.64	
Significance level %	0.00	

Summary and Conclusions

1. Data were collected from three groups of 30 subjects each to show the effects of bouts of exercises, which consisted of arm-curls, knee-bends, and bicycle riding of varying intensities, on neuromuscular tremor magnitude. The means of the data justify the following conclusions:

(a) The neuromuscular tremor magnitude varied directly with the strenuousness of the exercise.

(b) There was a coefficient of correlation of 0.043 between the maximum amount of work that the subjects accomplished and the neuromuscular tremor magnitude; thus, it was concluded that these factors were not related.

2. The effect of emotional stress was studied by comparing the neuromuscular tremor magnitude of 15 students, which was recorded under a nonstress situation, with the neuromuscular tremor magnitude resulting from the anticipation of a written examination. The data show that the emotional stress caused by the anticipated examination resulted in a neuromuscular tremor magnitude that was significantly greater than that exhibited under normal class situations.

3. The neuromuscular tremor magnitude of a group of 26 boys 12 to 14 years of age was compared with the neuromuscular tremor magnitude of a group of ten men 60 to 83 years of age. The data show that the neuromuscular tremor magnitude of the older group was significantly greater than that of the younger group.

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(Submitted 6-22-53)

Changes in Minimum Certification Requirements of Physical Education Teachers in 19 States Since 1947

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Abstract

This continuation study was commenced in 1942. Surveys are made each 5 years to ascertain the nature of changes as states revise their certification requirements. It is apparent from the findings that uniformity among states is not being reached and no two states yet have the same requirements.

A STUDY BY Morehouse and Schaaf (1) in 1942 showed a lack of agreement existing among state laws as to certification of physical education teachers. Morehouse and Aloia (2) in a follow-up study revealed that some changes had taken place in certain state requirements from 1942 to 1947, but that the lack of agreement still existed to the extent that no two states yet had the same requirement. A survey of the present certification requirements has been conducted to study the changes in requirements which have been made from 1947 to May 1, 1953.

Replies to requests for present minimum certification requirements in physical education were received from all 48 states. The form of presentation was altered in some instances for uniformity and the revised form was submitted to state officers for approval and correction before analysis.

Results

Twenty-nine states made no changes from 1947 to 1953. The statements of certification requirements of the 19 states which altered their physical education requirements since 1947 are presented in the Appendix (page ....). The changes are summarized in Table 1. These changes in requirement vary from an entirely new statement to changes within the 1947 statement. There are 14 states which have added to their requirements and 5 states which have reduced their requirements. Changes since 1947 are the following:

Georgia, in 1947, required 90 semester hours of work including 12 semester hours in physical education. Today, a Bachelor's degree which includes 30 semester hours of health and physical education is required.

Oklahoma, in 1947, required 90 semester hours of college training including 17 hours in physical education courses, allowing 8 semester hours of participation or activity courses, 1 semester hour of first aid, 2 semester hours of leadership, and 4 hours of theory of activity, including theory of intramurals. The new requirement is a Bachelor's degree with a minimum of 30 semester hours in health and physical education, with at least 8 semester hours in each area of health and physical education.

Idaho, in 1947, required a Bachelor's degree with a major or minor in physical education. The present Idaho requirement for certification is a minimum of 3 years of college with 96 semester hours, including 9 semester hours of professional education, 16 semester hours of upper division credit, and a minimum of 12 semester hours in any one subject field.

Louisiana and Ohio recently changed the designation "health and physical education" to the "physical education" certificate. Tennessee, Vermont, and

TABLE 1

Summary of Changes in State Requirements for Certification of Teachers in Physical Education

Change in requirements	States	Requirement (semester hours) 1947	1953
Increased physical education course requirements	Florida	21	30
	Iowa	20	26
	Mississippi	15	30
	North Carolina	30	36
	Wisconsin	20	30
Reduce physical education course requirement	California	40	36
	Indiana	22	18
	Minnesota	36	24
Emergency certificate instead of degree	Idaho	15	12
Bachelor's degree now required	Georgia	12	30
Physical education (formerly health and physical education)	Oklahoma		16
	Ohio	16	24
	Louisiana	41	20
Health and physical education (formerly physical education)	Tennessee	13	24
	Vermont		36
	Virginia	16	24
Certificate in appropirate major or minor	New Mexico	10	15
State instead of local requirement	Massachusetts		9
Semester hours instead of clock hours	Rhode Island		40

Virginia changed the certificate designation from "physical education" to "health and physical education." Florida, Tennessee, and Virginia are now specifying course requirements rather than listing total hours' credit as before.

Massachusetts now has a state certification requirement. This is the last state to change from local committee regulation to state requirement. The Massachusetts requirement to teach physical education is now a Bachelor's degree and 9 semester hours in education to be increased to 12 semester hours in education in 1954 and at least nine semester hours in a minor subject field or 18 semester hours in a major subject field or fields.

Minnesota and Wisconsin altered their unit requirements. Minnesota has reduced the units in physical education from 36 semester hours to 24 semester hours for the full-time teacher of physical education. Wisconsin has increased the units from a minor in physical education of 20 semester hours to a major in physical education of at least 30 semester hours.

New Mexico does not now have a special certificate for physical education. The State Department of Education has dropped the statement, "appropriate majors and minors with a minimum of 10 semeseter hours in physical educa-

tion; and in addition, 3 semester hours in the specific field taught." The new regulation is, "all teachers in high school must have a high-school certificate to include a 24-semester-hour major and 15-semester-hour minor in subjects taught in high school or two minors of 15 semester hours in subjects usually taught in high school."

Rhode Island has changed their certificate from a requirement of 400 clock hours in education and evidence of specialization in health and physical education to a minimum of 40 semester hours in appropriate and related courses in health and physical education, and in addition, "present a statement from an officer of the teacher-preparing institution regarding general fitness for teaching."

COURSE REQUIREMENTS ADDED

The trend toward the listing of specific courses and units in the state requirements indicates the desirability of reviewing the requirements in order to see which courses are affected.

Florida added 6 semester hours for men and "up to" 6 semester hours for women in Theory and Practice in Coaching Athletic Sports; 6 semester hours for men, 6 to 12 semester hours for women in Theory and Practice of Physical Activities; 1 course each in Program of Recreation, and Anatomy and/or Physiology.

Iowa added 4 semeseter hours in courses covering the principles of the school health program, and 2 semester hours in courses covering community recreation.

Mississippi added 15 semester hours in health education to include 3 semester hours of Family Life, 3 semester hours of Military Science, 3 semester hours in Personal Hygiene and/or Community Health.

North Carolina added 2 semester hours in Evaluation and Measurements in Health and Physical Education, and 2 semester hours in Curriculum of Physical Education.

Ohio added 6 semester hours in Human Anatomy and Physiology, 3 semester hours in Principles, Organization and Administration of Physical Education including Athletics and Recreation, 4 semester hours in Health and Hygiene, including Personal Health and Living, Community Health, Mental Health, Social Hygiene, Food and Nutrition, Sanitation, Disease Control, Health Counseling, and Athletic Injuries and First Aid.

Tennessee added 12 semester hours in physical education which must include Mass Gymnastics and Conditioning Exercise, Informal Games and Relays, Singing Games, Team Games, Individual and Dual Sports, Safety Skills in Outdoor and Aquatic Activities, Mimetics and Story Plays, Stunts and Tumbling, Modified or Adapted Activities for the Handicapped Student; 12 semester hours of health which must include Food and Nutrition, Safety Education and First Aid, Communicable Disease Control, Body Use and Care, Human Relations, and Sanitation of the Home, School, and Community.

Virginia added 8 semester hours to include Group Games, Team Sports, Rhythmics, Body Conditioning Activities, Recreational and Leisure-Time Ac-

tivities; 8 semester hours to include First Aid and Safety, Organization and Administration of School Health Program, Methods and Materials in Health Education, Safety, and Driver Education; 8 semester hours to include Curriculum in Physical Education, Principles of Physical Education, Organization and Administration of the Community Recreation Program, and Physiology of Exercise.

COURSE REQUIREMENTS REDUCED

Ohio dropped 4 semester hours of Principles, Organization, Administration of Health and Physical Education from their requirement.

Louisiana has eliminated all 3 semester hours of electives, and has lowered from 18 to 9 the semester hours of professional techniques in physical education.

North Carolina dropped the requirement of 3-4 semester hours of Hygiene, and 2-3 semester hours of Methods and Materials in Health Education.

California has adopted a revision of the certificate for physical education teachers to become effective September 15, 1955. The requirements for physical education will decrease physical education units from 40 semester hours to 36 semester hours; however, two courses of 2 semester hours each would be added to the professional education requirement. These two new courses would be School Community Health Program and Education for Leisure in School and Community Life.

Summary

The changes in state minimum certification requirements for physical education teachers since 1947 have been reviewed. The new requirements which have been established in the 19 states which have changed requirements since 1947 are different from those of any other state. The opportunity for progress toward uniformity has continued to be neglected. A summary of the findings follows:

1. Florida, Tennessee, and Virginia are now specifying course requirements. No state which heretofore has specified courses required for certification has discontinued this practice.
2. Fourteen states have increased physical education unit requirements for certificates.
3. Five states—California, Idaho, Indiana, Louisiana, and Minnesota—have reduced physical education credit requirements for certification.
4. Idaho is the only state to eliminate the requirement of a Bachelor's degree in physical education, and offers a "provisional certificate" after 3 years of college.
5. All states which listed semester hours' credit requirements along with course listings continue to do so. Eight states which have recently specified course requirements also specify unit requirements for each individual course.
6. Massachusetts is the last state to change from a local physical education requirement to a state certification regulation.
7. No two states yet have the same certification requirements.

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APPENDIX

Changes in State Minimum Certification Requirements for Physical Education Teachers Since the 1947 Study

California

1947: A four-year college course with a Bachelor's degree, including 24 semester hours in physical education and 15 semester hours of professional work in education. Must be physically and mentally fit to engage in teaching service.

Minimum of 16 semester hours in the fields of English, science, social studies, and physical education.

Minimum of 15 semester hours from at least four of the following: biology, anatomy, physiology, hygiene, psychology, sociology, chemistry.

Minimum of 24 semester hours selected from at least seven of the following, with a minimum of 6 semester hours in activities in phsical education: principles of physical education, techniques of teaching activities, administration of physical education, kinesiology (applied anatomy), applied physiology (physiology of exercise), activities in physical education, community recreation, individual program adaptations (corrective physical education), physical education tests and measurements, health education, growth and development of the individual.

1953 (effective 1955): A Bachelor's degree including 40 semester hours of general education, to include 12 semester hours of sciences basic to physical education and 6 semester hours each in fine arts, social studies, and communications; 22 semester hours of professional education to include the scope, function, and structure of elementary and secondary school education and the role of public education in our American democracy; the learner in society, curriculum development, general methods, role of the teacher in guidance, evaluation of instruction; program; evaluation for leisure in school and community life; directed teaching distributed in grades 7 through 12, and 36 semester hours in a physical education major sequence to include principles and historical background; a core of applied science basic to movement including kinesiology, physiology of exercise, adaptive activities, health; proficiency in and ability to use specific teaching methods and officiating in aquatics, rhythms, and dance, games, relays, social activities, individual and dual sports, team sports, gymnastics, individual adaptive activity, combatives suitable for boys in the secondary school; organization and conduct of physical education; curriculum materials and evaluation including directed observation and field experience; role of the teacher in recreation education.

Florida

1947: Graduation from an institution which requires 4 years of training; with 6 semester hours each in science, social studies, and English; with 18 semester hours in education, not including psychology courses; and with 21 semester hours in health education and physical education, of which not more than 9 semester hours may be coaching courses. If college courses do not include 5 semester hours in American history and government, an examination on the Constitution of the United States must be passed.

1953: Graduation from an institution which requires 4 years of training; a minimum of 30 semester hours of physical education to include 24 semester hours of physical education consisting of theory and practice in coaching athletic sports, 6 for men, 0 to 6 for women; theory of practice of other physical activities, 6 for men, 6 to 12 for women; program of physical education, 6 hours; 1 course each in program of recreation and anatomy and/or physiology.

Georgia

1947: Ninety semester hours of college work, including 9 semester hours of approved education and 12 semester hours of physical education. A professional certificate would require 18 semester hours' credit in education.

1953: Bachelor's degree, general and professional education to include general education, understanding the learner, understanding the community and general curriculum construction, specific methods and material, acquiring material in teaching and professional responsibilities; 30 semester hours in health and physical education differentiated for men and women to include health education, physical education, recreation, and safety. Each institution plans its own curriculum.

Idaho

1947: A Bachelor's degree with a major or a minor in physical education.

1953: Provisional certificate effective for school year, 1953-54 and valid for 3 years for grades 7 through 12, requires a minimum of 3 years of college with at least 96 semester hours which shall include 9 semester hours' professional education consisting of 3 semester hours of general secondary methods; 16 semester hours of upper division credit; 12 semester hours in any subject field.

Indiana

1947: Graduate with a baccalaureate degree with 15 semester hours in education. Also 22 semester hours of physical education which shall include: orientation and organization, 4 semester hours; tests and measurements in health and physical education, 3 semester hours; technique:

(a) Sports, highly organized—3-4 semester hours.
(b) Sports, recreational—3-4 semester hours.
(c) Gymnastics (tumbling, apparatus tactics, calisthenics, body mechanics, and individual athletic events—3 semester hours).
(d) Rhythmic activities (folk, clog, social, modern, tap), 3-2 semester hours.
(e) Activities for elementary grades—3-2 semester hours.

1953: A Bachelor's degree with a requirement of 18 semester hours of professional education to include 2 semester hours of educational psychology, 2 semester hours of educational psychology, 2 semester hours of general methods, 2 semester hours of principles of learning and teaching in the secondary schools, 2 semester hours of guidance, 2 semester hours of special methods in comprehensive area, 5 semester hours in student teaching, 3 semester hours of elective, and 18 semester hours of physical education and a requirement to complete 3 hours annually until 24 semester hours are completed.

Iowa

1947: A degree or diploma from an institution approved by the board of education examiners. This degree shall include 15 semester hours of professional training and not less than 20 semester hours in physical education, including: courses covering principles, administration, methods, and supervision of physical education—6 semester hours; courses covering methods of specialized physical education activities (credit given only for lecture hours)—10 semester hours.

A teacher may teach physical education in a small high school with less than four teachers if he has had a minimum of 4 semester hours of physical education. A teacher may teach physical education less than half time if he has had 10 semester hours' training in physical and health education.

1953: Graduation from a four-year teacher-education curriculum leading to a baccalaureate degree with 20 semester hours of credit in professional education and 4 semester hours of credit in methods of teaching physical education in the elementary school field and in the secondary-school field. In addition, each candidate for a special certificate for physical education must complete 26 semester hours of credit distributed as follows:

(a) Six semester hours of principles, management, and direction of physical education programs including playground activities.

(b) Four semester hours in principles of the school health program.
(c) Ten semester hours in methods of specialized physical education activities (credits only for class hours, not for participation on an athletic team).
(d) Two semester hours in community recreation.
(e) Four semester hours in electives in physical education.

Louisiana

1947: A four-year degree and for certification as a fully qualified teacher of health and physical education or coach the requirement is 41 semester hours distributed as follows:

1. Principles, organization, and administration—5 semester hours.
2. Basic science—3 semester hours.
3. Health education—6 semester hours.
4. Professional techniques—18 semester hours.
5. Anatomy and physiology—6 semester hours.
6. Electives in physical education—3 semester hours.
   (A definitely established evaluation of the distribution of these hours is done by the director of certification with the co-operation of the state supervisor of health, physical, and safety education.)

1953: A four-year degree with a minimum of 46 hours in general education, 18 semester hours in professional education, and 20 semester hours of physical education to include 5 semester hours principles, organization and administration, 6 semester hours basic science (anatomy, physiology, and kinesiology), 9 semester hours professional techniques in physical education not to include more than 4 hours in coaching classes.

Massachusetts

1947: For less than half-time work in physical education, the teacher must be a graduate from a four-year college and must have had 15 semester hours in physical education. Eight semester hours of the 15 must be in skills plus teaching technique, and the remaining 7 semester hours in theory courses in health and physical education.

For full-time work in physical education (work requiring half or more of the teacher's time), an approved four-year teacher-training course of 36 semester hours in physical education in an institution approved by the State Department of Education is required.

1953: A degree is required in a teacher-training course of physical education with 9 semester hours of professional education and with a minimum of 9 semester hours in physical education.

Mississippi

1947: Recommends a 120-hour course, which consists of 21 semester hours of physical education and 18 semester hours of professional education. At present the approval of these teachers is left to the discretion of the high-school supervisor.

1953: Bachelor's degree from an approved teacher's institution, to include 48 semester hours of general education, 18 semester hours of professional education, and 30 semester hours of special education consisting of 15 semester hours in physical education and 15 semester hours in health education. Three semester hours each is required in the courses, Family Life Education, Personal Hygiene and/or Community Health, and Military Science or Physical Education.

New Mexico

1947: A college degree with appropriate majors and minors with a minimum of 10 semester hours in physical education, and in addition 3 semester hours in the specific subject taught.

1953: A college degree is required from an approved institution. All teachers in high school must have a high-school certificate with a minimum of 16 semester hours of professional education and academic credit distributed in a 24-semester-hour major and a 15-semester-hour minor in subjects taught in high school or 2 minors of 15 semester hours in subjects usually taught.

North Carolina

1947: Thirty semester hours major in order to teach full time; 6 to 8 semester hours of biological and physical science, 6 to 8 semester hours of social sciences are recommended as prerequisites. Human anatomy and physiology—6 semester hours. Principles, organization, administration, supervision of physical education and health education—3 to 4 semester hours. Physical education skills and applied techniques—12 semester hours (group games of low organization, dual and single games, group games of high organization, rhythms and dances, gymnastics and stunts, aquatics). Individual corrective physical education—2 to 3 semester hours. Hygiene—3 to 4 semester hours. Methods and materials in health education—2 to 3 semester hours.

1953: A graduate of a standard four-year college with a professional educational requirement of 18 semester hours and 36 semester hours of health and physical education distributed as follows: 6-10 semester hours of principles, organization, administration and supervision to include principles of health education, principles of physical education, organization and administration of health and physical education, evaluation and measurements in health education, curriculum in physical education. At least four areas must be included in this requirement. Ten to 12 semester hours in applied techniques to include methods and materials in group games of low organization, methods and materials in individual sports, methods and materials in aquatics, methods and materials in rhythmics, methds and materials in tumbling stunts, methods and materials in team sports—minor, methods and materials in team sports—major. At least five areas must be included in this requirement. Four to 6 semester hours in individual physical education; kinesiology may be included; 4 to 6 semester hours in health education to include first aid and athletic injuries and problems in health education; 6 semester hours in anatomy and physiology; 6 semester hours in biological science.

Ohio

1947: Graduation from a four-year college course which includes 17 semester hours in professional preparation and minor of 16 semester hours in health and physical education which shall be distributed as follows:

Principles, organization, and administration of health and physical education—4.
Theory and practice, including stunts, apparatus, tumbling, swimming, dancing, etc.—4.
Theory and practice, including athletic coaching in intramural and intersholastic athletics—4.

1953: A graduation from a four-year college course which includes 17 semester hours in professional education and 24 semester hours in physical education to include 3 semester hours in principles, organization and administration of physical education including athletics and recreation, 4 semester hours in activities, skills and methods of teaching rhythms, games of low organization, stunts, tumbling, apparatus, recreational group activities. Four semester hours in activities, skills and methods in teaching athletic sports, including football, basketball, baseball, track, tennis, golf, swimming, soccer, speedball, volleyball and other commonly used activities in secondary and college programs. Three semester hours in methods and materials, teaching health including evaluation and selection of health materials; four semester hours health and hygiene, including personal health and living, community health, mental hygiene, social hygiene, food and nutrition, sanitation, disease control, health counseling, athletic injuries; and six semester hours in human anatomy and physiology.

Oklahoma

1947: Ninety semester hours of college training, 10 semester hours of which are in education courses and 17 semester hours of which are in physical education courses, including activity or participation courses—8; first aid—1; boy and girl leadership—2; theory of activities, including theory of intramurals—4.

1953: Bachelor's degree from a standard approved institution for teacher education. The degree to include 50 semester hours of general education, 21 semester hours' professional education and a minimum of 30 semester hours in health and physical education, with at least 8 semester hours in health education and 8 semester hours of physical education.

Rhode Island

1947: Graduate of a four-year college course which includes 400 clock hours in education and 400 clock hours in physical education.

1953: Bachelor's degree from an institution approved by the State Board of Education. Twenty-four semester hours of education courses approved for special subject teachers, including Rhode Island education and not less than 6 semester hours and no more than 12 semester hours of practice teaching. A minimum of 40 semester hours is required at appropriate and related technical courses in health and physical education. It is necessary to present a statement from an officer of the teacher-preparing institution regarding general fitness for teaching.

Tennessee

1947: Graduation from a four-year college or university. Course must have included 27 quarter hours in education and at least 20 quarter hours in physical education.

1953: Graduation from a four-year college or university. Course must include 36 quarter hours (24 semester hours) in education and at least 36 quarter hours (24 semester hours) in health and physical education divided as follows: 18 quarter hours (12 semester hours) of health which must include foods and nutrition, safety education and first aid, communicable disease control, body use and care, human relations, sanitation of the home, school, and community; Eighteen quarter hours (12 semester hours) in physical education which must include mass gymnastics and conditioning exercise, informal games and relays, singing games and relays, team games, individual and dual sports, safety skills in outdoor and aquatic activities, mimetics and story plays, stunts and tumbling, modified or adapted activities for the handicapped student. Credit or required activity courses and/or military science may not apply.

Vermont

1947: Baccalaureate degree in physical education. This degree must also include a minimum of 12 semester hours in education courses.

1953: A Bachelor's degree from a four-year program in an institution approved by the State Board of Education which shall include 18 semester hours of professional education and 18 semester hours of health and physical education.

Virginia

1947: Baccalaureate degree which shall include 6 college session hours (12 semester hours) in physical education and 9 college session hours (18 semester hours) in teacher-training courses.

1953: A Bachelor's degree conferred by an accredited institution, which includes 18 semester hours of professional education, 6 semester hours in health and physical education and safety in general education requirement, and 24 semester hours of health and physical education, which includes: 8 semester hours of group games, team sports, rhythmics, body conditioning activities, recreation and leisure-time activities; 8 semester hours in first aid, safety, organization and adminstraton of school health program; 8 semester hours in curriculum in physical education, principles of physical education, organization and administration of community recreation program, and physiology of exercise.

Wisconsin

1947: Graduation from an accredited four-year college or university course with a minor of at least 20 semester hours in physical education.

1953: Professional education of 18 semester hours to include 3 hours of educational psychology or psychology of learning, 2 semester hours of methods course in physical education, 5 semester hours of practice teaching, and 8 semester hours of electives. Graduation from an accredited four-year college or university course with a major of at least 30 semester hours in physical education; 2 teaching minors of 15 semester hours each is required.

(Submitted 6-20-53)

Relationship Between Somatotype and Motor Fitness in Women

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Abstract

In this study four motor fitness tests were given to 83 physical education majors and approximately 100 non-majors who had been somatotyped by Sheldon. Correlations between test scores and somatotype components were computed using the Pearson product moment method. The two groups were compared by determining the means and standard deviations of each component. It was found that the physical education major group tended to have slightly more dominant mesomorphic traits. Significant relationships were indicated between mesomorphy and strength and power. Inverse relationships were indicated between endomorphy and strength and power.

THE STUDY OF gross body build and its relation to physical fitness and athletic performance is comparatively new to women's physical education. Until recently, the somatotyping procedure has been limited to small groups in attempts to determine standards of physique for adult women (1) and in the study of disease (9, *pp. 784-788*).

Cureton (2, *p. 301*) refers to body build as a factor in the interpretation of physical fitness and athletic performance. Larson (6, *p. 18*) includes body build as a constituent of physical fitness. This study[1] was made in an attempt to establish the relationship between somatotype and motor fitness. The elements of motor fitness tested are: agility, flexibility, power, and strength. Cureton (3, *p. 112*) considers these to be four of the fundamental aspects of motor fitness.

The basic problem was to determine the relationship between somatotype ratings and the four elements of motor fitness for two groups of women. These two groups were major students in physical education and non-majors enrolled in physical education service courses at the University of Illinois. For clearer understanding, the problem was divided into two parts. The first of these was to determine and compare the distribution of somatotype ratings for both groups of women. The second was to determine the relation of each motor fitness trait to each of the three somatotype component ratings, and compare the two groups.

Procedure

Somatotyping. The somatotype ratings used for this study are a part of those made in Dr. W. H. Sheldon's survey of women in an effort to establish norms for women's physique. A group of Dr. Sheldon's assistants visited the Illinois campus and photographed approximately 630 women, of whom ap-

[1]Submitted in partial fulfillment of the requirement for a Master of Science degree in Physical Education at the University of Illinois, September 1950.

proximately 90 were majors in the field of physical education. The development of the negatives and the somatotyping were done in the Human Constitution Laboratory College of Physicians and Surgeons, Columbia University.[2]

Dr. Sheldon's somatotyping procedure is based on the theory that the human physique is made up of a mixture of three components. The three components, found after inspection of 4,000 male photographs, were named endomorphy, ectomorphy, and mesomorphy according to the embryonic layer from which Sheldon believes each variant develops. To clarify the characteristics of each of the three extremes, checklists of criteria were established (10, *pp. 37-45*). A brief summary of these lists follows:

Endomorphy

(a) round and soft
(b) central concentration of mass
(c) smoothness of contours, no muscle relief
(d) bones are small
(e) resemblance to female in thighs and lower legs

Mesomorphy

(a) body square and hard, massive muscling with large prominent bones
(b) trunk and limbs large and heavily muscled
(c) slender waist; broad shoulders; long, upright trunk; broad hips

Ectomorphy

(a) linearity, fragility, and delicacy of body
(b) small, delicate bones with thready muscles

Each of the three components is rated on a 7-point scale, the higher rating indicating predominance. The photographs used in this study were rated in one-half steps to permit more reliable statistical analysis.

Testing. One phase of each of the four elements of motor fitness was tested. These tests were chosen with reference to their reliability; validity; and administrative practicability in relation to available space, equipment, and personnel. The elements of motor fitness and the tests used were:

1. Flexibility	Trunk Extension
2. Agility	Illinois Agility Run
3. Strength	Knee Push-up
4. Power	Medicine Ball Put

The tests were given to all students majoring in physical education who were somatotyped the first semester of 1949-50 and were still enrolled in school the second semester. Exceptions were made for those students who could not participate in all tests because of injuries.

Students enrolled in the service curriculum were contacted in their physical education classes, or asked to come to special testing periods. Those who took the tests during class periods were tested on only one or two items of the test battery. It was necessary to vary the order of the tests, for those who came to special testing periods, in order to administer the agility run and medicine ball put between class periods.

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[2]A detailed explanation of the somatotyping procedure can be found in *The Varieties of Human Physique* by W. H. Sheldon, S. S. Stevens, and W. B. Tucker (10).

It was possible to test a random sample of at least 100 women enrolled in the service curriculum on all tests. The tests were given to 83 students majoring in physical education.

During the special testing periods, a group of trained assistants aided in administering the tests. These assistants and the investigator read uniform directions to all subjects for each test. These directions were supplemented with a demonstration of proper technique.

Statistical Procedures. The Pearson product moment method was used to determine the reliability of three of the tests used. The limitations and all-out requirement of the knee push-ups prohibited retesting. The probable error of each reliability was also computed. Since all test reliabilities were computed using self-correlation based on two consecutive trials, the Spearman-Brown prophecy formula was used to determine the effect of doubling the test length.

The distributions of the data were determined by plotting the somatotype component ratings on a frequency distribution table. The means and standard deviations for the distributions were calculated using the short methods described by Garrett (5, *pp. 387-388*). The standard error of the mean was also computed. The significance of the difference of the means was found by determining the standard error of the difference and the critical ratio.

Correlations between test scores and separate component ratings were computed through use of the Pearson product moment method. The probable error was also computed.

Significance of the coefficients of correlation was determined through reference to Table 49 in Garrett (5, *p. 299*) and Table 13 in Lindquist (7, p. *212*).

Results

SOMATOTYPE RATINGS OF ENTIRE POPULATION

Table 1 indicates that endomorphy tends to be the most dominant component among the 634 University of Illinois women who were somatotyped.

TABLE 1

Mean and Standard Deviation of Distributions for Each Somatotype Component Rating—634 Women

Component	Mean	Standard Deviation
Endomorphy	4.7650	.925
Mesomorphy	3.1427	.840
Ectomorphy	3.2177	1.115

The range of ratings in the endomorphic component were from 1^2 to 7^2, the rating of the ectomorphic component ranged from 1 to 7, and the range of the mesomorphic component was from 1 to 5^2.[3] There were no extreme mesomorphs in the group.

[3]The use of 1^2, 2^2, etc., indicates half-steps in the rating scale.

SOMATOTYPE RATINGS OF 541 WOMEN IN SERVICE CURRICULUM

Table 2 indicates that there was little difference between this sub-group and the entire population. There was no difference in range.

TABLE 2

Mean and Standard Deviation of Distributions for Each Somatotype Component Rating—541 Women Not Majoring in Physical Education

Component	Mean	Standard Deviation
Endomorphy	4.7800	.935
Mesomorphy	3.1427	.840
Ectomorphy	3.2177	1.115

SOMATOTYPE RATINGS OF 93 PHYSICAL EDUCATION MAJORS

Table 3 indicates a lower mean for the endomorphic component for this sub-group than for either the entire group or the sub-group consisting of non-physical education majors. The mesomorphic mean is higher than that of the entire group, or of the larger sub-group.

TABLE 3

Mean and Standard Deviation of Distributions for Each Somatotype Component Rating—93 Women Majoring in Physical Education

Component	Mean	Standard Deviation
Endomorphy	4.5699	.900
Mesomorphy	3.6344	.795
Ectomorphy	3.1290	1.010

The endomorphic component ratings for the major group ranged from 2 to 7, the ectomorphic ratings from 1 to 6^2, and the mesomorphic ratings from 1^2 to 5^2.

COMPARISON OF THE TWO GROUPS

The differences in range indicate a higher degree of mesomorphy in the major group, with less marked prominence of the ectomorphic component. There is also a tendency toward more marked endomorphic characteristics.

TABLE 4

Comparison of the Distribution of Component Ratings of the Non-Major and Major Groups

Component	Non-majors		Majors		Difference	σ	Critical Ratio
	Mean	σ	Mean	σ			
Endomorphy	4.7800	.935	4.5699	.900	.2101	.1014	2.0719
Mesomorphy	3.1427	.840	3.6344	.795	—.4917	.0894	5.5000
Ectomorphy	3.2177	1.115	3.1290	1.010	.0887	.1153	.7692

The critical ratios in Table 4 indicate no statistically significant differences between the two groups in relation to the endomorphic and ectomorphic components. The critical ratio of the difference between the means for the two groups on the mesomorphic component is significant. This indicates a tendency for the group of physical education majors to be more mesomorphic.

TEST RELIABILITIES

Table 5 indicates the reliabilities of three of the tests used in this study. These reliabilities were based on two consecutive trials taken during one testing period.

TABLE 5
Test Reliabilities

	N	r	P.E.	Step-up
Flexibility				
Trunk Extension	51	.9583	.0075	.9795
Agility				
Illinois Agility Run	184	.7774	.0197	.8707
Power				
Medicine Ball Put	179	.8867	.0113	.9399

The time element and all-out effort required by the knee push-up test prohibited retesting any subjects. Mohr (8, *p. 342*) reports a reliability of .925 for the knee push-up.

RELATIONSHIP BETWEEN MOTOR FITNESS TRAITS AND SOMATOTYPE RATINGS

Flexibility. Table 6 indicates no statistical significance between trunk extension and the three somatotype ratings for either group.

TABLE 6
Correlation Between Trunk Extension and Each Somatotype Component Rating

Components	Non-majors N	Non-majors r	Non-majors P.E.	Majors N	Majors r	Majors P.E.
Endomorphy	172	.0070	.0517	81	—.0942	.0747
Mesomorphy		.1458	.0507		.0265	.0754
Ectomorphy		—.0606	.0515		.0270	.0754

Strength. Table 7 indicates a correlation coefficient of $-.3862 \pm .0577$ for endomorphy and knee push-ups for 100 women enrolled in the service curriculum. This correlation is significant at the .01 level of confidence and indicates an inverse relationship between endomorphy and knee push-ups. The same correlation based on test scores of 83 physical education majors was not statistically significant. The presence of a higher degree of mesomorphy in the major group may have influenced the latter correlation.

The correlations for both groups between mesomorphy and knee push-ups are statistically significant at the .01 level of confidence indicating a positive relationship between mesomorphy and knee push-ups.

TABLE 7
Correlation Between Knee Push-Ups and Each Somatotype Component Rating

Component	Non-majors N	Non-majors r	Non-majors P.E.	Majors N	Majors r	Majors P.E.
Endomorphy	100	—.3826	.0577	81	—.0491	.0753
Mesomorphy		.3908	.0567		.4437	.0608
Ectomorphy		—.0874	.0670		—.2568	.0703

Neither of the correlations between ectomorphy and knee push-ups were statistically significant.

In an unpublished study, Patricia Collins tested 124 of the Illinois women on dynamometer strength tests, including back, leg, and right and left grip strength. Correlations of the composite strength test scores with each of the three somatotype components indicate positive relationship between test scores and mesomorphy and endomorphy. The relationship between ectomorphy and the composite scores was inverse.

Agility. Table 8 indicates a negatively significant relationship between endomorphy and agility at the .02 level of confidence for women enrolled in the service curriculum. The test scores for the physical education group are not significantly related to endomorphy. The difference between these two correlations may have been caused by the presence of higher mesomorphic tendencies in the major group, which would tend to raise the correlation.

None of the correlations between mesomorphy and agility or ectomorphy and agility are statistically significant.

TABLE 8

Correlation Between the Illinois Agility Run and Each Somatotype Component Rating

Component	Non-majors			Majors		
	N	r	P.E.	N	r	P.E.
Endomorphy	100	—.2469	.0636	83	—.1334	.0728
Mesomorphy		.2201	.0642		.1936	.0713
Ectomorphy		.0046	.0674		.0395	.0720

Frank found a positive relationship between the Illinois Agility Run and reaction time. She found no significant relationship between the ponderal index and reaction time (4, *pp. 65, 66*). This information further supports the relations found in this study, since the ponderal index is a determinant of constitutional body type (10, *p. 82*).

Power. The correlations indicated in Table 9 between endomorphy and test scores and ectomorphy and test scores are not statistically significant. A direct relation of mesomorphy to power is indicated by the coefficient of correlation for the physical education major group. The coefficient of correlation between mesomorphy and test scores is not significant for the non-major group.

TABLE 9

Correlation Between the Medicine Ball Put and Each Somatotype Component Rating

Component	Non-majors			Majors		
	N	r	P.E.	N	r	P.E.
Endomorphy	102	—.0202	.0674	82	—.1559	.0735
Mesomorphy		.1968	.0648		.3769	.0645
Ectomorphy		.0000	.0674		.0936	.0747

The ability to put the medicine ball is dependent on ability to gain added momentum through proper use of the body. Many of the physical education

majors had taken this test previously and had also had training in the use of proper body technique to gain force.

Conclusions

The following conclusions were evolved with respect to the data and limitations of this study and reports of other studies:

1. Endomorphy is the dominant component of the group of Illinois women somatotyped.
2. Women who choose physical education as a major tend, as a group, to have more dominant mesomorphic traits than do those enrolled in service courses at the University of Illinois.
3. This study indicates that there is no relationship between somatotype ratings and trunk extension.
4. There is a significant relationship between mesomorphy and knee push-ups. There is also a negatively significant relationship between endomorphy and knee push-ups when the mesomorphic component is low.
5. There is an inverse relationship between endomorphy and the Illinois Agility Run when the mesomorphic component is not prominent.
6. The medicine ball put and mesomorphy are significantly related, when the subjects have previous knowledge of the test and throwing technique.

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(Submitted 6-10-53)

Learning Rate of Beginning Swimmers

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Abstract

The two parts of the study are based on the same experimental method of instruction. Basic assumptions relative to method are listed. Part I reports progress of 20 swimmers taught in small groups, and Part II, 134 in regular classes. All were college women, non-swimmers. Criterion for "learning to swim" was passing a 15-minute endurance test. Progress in small groups and classes was similar; the majority can "learn" in 15 lessons or less, the minimum learning time was 5 lessons; the accomplishments of the first lesson are indicative of probable learning rate; swimmers can be introduced successfully to deep-water skills in second or third lesson.

BEGINNERS IN swimming often make discouragingly slow progress. Young children usually enjoy the learning process sufficiently that they are not disturbed by the time spent in relation to swimming competence. For the college age or adult learner, obvious slowness is frequently sufficient to destroy interest.

It would seem that instructors should be more analytical of abilities of the learner and of factors apparently related to swimming learning. Also it would appear probable that the learning rate might be substantially increased with efforts directed to that end.

Previous studies have indicated that there is a complex pattern of factors operating on the novice swimmer. Knelleken (3) and Elliott (2) both said attitude seemed to be the greatest factor toward learning. Knelleken further indicated that relatively warm water temperature and knowledge of general safety practices aided learning, that the vertical float and treading gave confidence and could be started early. Solleder (5) adds to this list of aids ability to relax. Elliott found motor ability to be a fair indication of learning rate, while the other two and Baker (1) did not find such relationship. All found wide individual differences in learning rate. These studies were all on college women.

It was the purpose of this study to determine:

1. Learning rate of college women following a prescribed course of swimming instruction in different class sizes.
2. Relationship of learning rate and
   (a) Motor ability.
   (b) Swimming competence.
   (c) Frequency of practice.

Procedure

The prescribed course of instruction was determined to a large extent by the pattern of progression and the goal of the basic skills program in the Department of Physical Education for Women at the University of Iowa. The aims of the course are to make the individual safe in the water and to lead

her to desire to use her swimming skill as a means of recreation. The test is a 15-minute keep-up.[1] The swimmer is ordinarily given experience in breathing in the water, floats and recoveries, elementary back stroke, side stroke, treading, change of direction, and elementary diving from side of pool (see Appendix, page 99).

In organizing these skills for presentation, certain underlying assumptions were made regarding methods to be employed and progression to be followed. These assumptions are:

1. Swimmer must be enabled to accomplish something new each lesson.
2. Swimmer must be made to feel confident.
3. Swimmer must be kept practicing on something which is a challenge to her.
4. Swimmer must be praised as liberally as possible.
5. Swimmer must be protected from failure; must not be kept on a skill she does not readily acquire.
6. Swimmer must be made self-sufficient, thoughtful, and self-analytical.
7. Swimmer must *not* be coached on small *unnecessary* details until she feels confident on the total skill.
8. Swimmer must be taught always in positive terms and with feelings of confidence. (*Do* this! Avoid saying or letting her think she must *not* do something or swim somewhere.)
9. Swimmer must have clear-cut idea of ultimate and immediate goals.

This study was carried out in two parts. Part I dealt with carefully screened *beginners* who were taught in small classes to facilitate very close records. Part II dealt with regular swimming classes, designated as beginners but in which some registrants may have had a little experience in the water though classed as beginners. The teaching was in classes varying from 11 to 24, median-sized class being 20.

PART I

In order to carry out this part of the study it was considered essential to have absolute beginners. By studying the student records showing previous experience in swimming and by interviewing students, it was possible to secure a group who had had no instruction or practice in the water and who expressed no fears relative to swimming or being in the water. Students selected were assigned to one of four groups as follows: 7:30 M W F — 5; 8:30 M W F — 6; 8:30 T Th — 4; 11:30 M W Th F — 5.

The lessons started the third week in November and extended into January with two vacations, Thanksgiving and Christmas, falling into this interval. Lessons were carefully timed to 30 min. and never varied more than 2 or 3 min. for any swimmer. Make-ups were held on Saturday mornings and any girl absent during the week was asked to come for a make-up in order to keep the number of days per week as constant as possible.

Instructions were all presented by the investigator, and an assistant kept the record of accomplishments for the day and assisted with individual

[1] 15 minute test: Headfirst entry in deep water, level off and tread two minutes; swim five lengths—any strokes, but only one length on back; keep up for remainder of fifteen minutes. (Length of pool was 60 feet.)

coaching in some cases when groups became widely divergent. Abbreviated lesson plans appear in the Appendix, page 99.

Each student was asked to continue coming one lesson beyond that required to pass the 15-min. test and was permitted to continue as long as the rest of the group if she chose to do so. Lessons were terminated at 12th to 17th lesson for the slower learners depending upon their attendance record. On the lesson following the passing of the test, five judges observed the swimmer and rated her on form and safety. These combined ratings were considered a measure of competence in the water. The form events were back stroke, side stroke, and treading. Safety was judged on relaxation, ease and confidence in doing the above strokes in deep water and in making a series of changes in body position, change of direction, and continuous swimming in deep water. All judging was on a five-point scale. All swimmers not completing the test were also rated at the end of the series of lessons.

Motor ability was measured by the Scott Motor Ability battery (6) which was administered to all students at the beginning of the school year.

On the first day in the water each case was rated by the investigator and an assistant for trust of the water and willingness to try. Seven were judged to show more or less of a fear reaction. The proportion and severity of fear responses was judged comparable to that in a similar-sized class.

Analysis of the Data

Little consideration could be given to motor ability level in selecting subjects. They were found to fall into the following quartiles in relation to total Freshman performance in motor ability: High quartile—3; 3rd quartile—2; 2nd quartile—3; Low quartile—12.

The high proportion of low-quartile students was due to the fact that they are required to take a special class on entering and had not had opportunity to elect swimming. Therefore, they constituted most of the group available at mid-semester.

The effect of motor ability was studied in various ways. The sum of the judges' ratings given on the 20 swimmers was correlated with the motor ability scores. This coefficient was .52, which is significant at about the 2-percent level. This gives some indication of relationship between success and motor ability.

The 20 cases were studied further by putting them into three categories; namely, those passing the test in 10 lessons or less, those passing in 11 or more, and those not passing. The results are in Table 1.

This would seem to indicate a relationship between motor abilty level and rate of achievement. Also the judges' rating of swimming form and safety parallels rather closely the achievement groupings.

The proportion of fear cases in the group and the intensity of the fears exhibited were considered typical of average classes in beginning swimming. However, the above data would lead one to conclude that even mild fears

might be a delaying factor and that they might be associated with lower levels of motor ability.

Instructors have frequently found that the first lesson is a crucial one. Analysis was made of the first lesson to determine what was accomplished. For these 20 subjects, the first-lesson achievement records showed:

Breathing rhythmically and holding breath	19 passed
Jelly-fish float	18 passed
Prone float and recovery	17 passed
Flutter kick with progress in water	17 passed
Back float and recovery	16 passed
Backstroke across (24 ft.)	1 passed

This would seem to indicate that the first lesson should progress through the first five items above for all swimmers and should introduce the backstroke for all who are working on back floats.

Correlation was computed between judges' final ratings and the number of tests passed the first day. The coefficient was .60, which is significant at the 1-per-cent level. The coefficient between the number of tests passed the first day and the day on which the 15-minute test was passed was —.46. These

TABLE 1
Comparison of Promptness of Test Passing and Motor Ability, Judges' Rating, and Initial Fear

Lessons	N	M of Motor Ability	M of Judges' Ratings	# of Fear Cases 1st day
10 or less	5	52.4	76.9	0
11 or more	11	44.3	65.6	4
Not passing	4	38.3	36.5	3

would seem to indicate a relationship between early achievement and ultimate competence and speed of arriving at this defined level of safety. The relationship is not high enough, however, that one should assume individual prediction of rate to be accurate. The swimmer should be continually challenged with new goals as rapidly as she can progress.

The comparison of the 4-, 3-, 2-day-per-week schedule is not conclusive, as shown by Table 2. The differences in mean number of days to reach the point of passing the test is in no instance statistically significant. Probably the

TABLE 2
Comparison of Rate of Passing Tests and Frequency of Practice

Group		Motor Ability	Back-stroke Across	Back-stroke Length	Treading	Side-stroke Length	15 Minute Test
4 days/week	N	5	5	5	5	5	5
	M	47.0	3.0	3.4	9.8	9.4	12.6
3 days/week	N	12	12	12	9	9	9
	M	45.3	2.9	4.0	9.4	7.6	11.6
2 days/week	N	4	4	4	4	3	2
	M	44.0	3.0	3.3	9.5	8.7	11.0

most significant factor to be noted in Table 2 is the proportion of cases achieving each level. In all three groups, 100 per cent of the swimmers were able to swim the backstroke the length (60 ft). Beyond that the *4-day* group continues at 100 per cent while the other two decline to a general 75-per-cent level. The *4-day* group achieved 100-per-cent record, in spite of the fact that there were three from the lower motor ability quartile and a fourth who was rated as a marked fear case the first day and continued to show fear for several lessons. The fifth was the case with the highest score in the entire study, several points above any others. The mean motor ability of the 4-day group is not significantly above the others, the slight difference being due to the presence of the one high score. No conclusive statements can be made about the three groups because of the low number of cases in each group.

Since no conclusive differences are shown on frequency of practice, and since we are interested in all ranges of ability in considering learning rate in a swimming class, all subjects were considered together in studying learning rate. This rate is shown in Table 3. Study of the low end of the range reveals the daily progress of the most rapid learner who completed the entire series in five lessons. The two measures of central tendency, when considered together, give a clear picture of the progression of the majority of the swimmers.

TABLE 3
Learning Rate of All Subjects
Expressed as Lesson on Which Test Was Passed

Test Item	N	Range	Mdn.
Elem. backstroke, across	20	1-8	2
Elem. backstroke, length	20	2-12	3
One arm side stroke, length	17	3-12	8
Treading (acceptable form)	20	3-13	4
Treading (30 sec. continuously)	20	4-13	6
Treading (60 sec. continuously)	19	5-12	8
Treading (120 sec. continuously)	18	5-15	9
Two-arm sidestroke, length	12	4-14	9
Standing dive	16	5-16	10
15-min. test	16	5-17	11

The accomplishments of the "typical" learner might be described as follows:

	Lesson
Breathing, floats, flutterkick	1
Elementary back across pool	2
Elementary back length of pool	3
Good form for treading	4
Continuous treading, 30 sec.	5
Plateau	6-7
One-arm side stroke, length	8
Continuous treading, 60 sec.	8
Continuous treading, 120 sec.	9
Two arm side stroke, length	9
Standing dive in acceptable form	10
15-min. test	11

Eleven lessons means between 5 and 5½ hr. of practice time. This represents average learning time for this standard of achievement.

In considering application of these findings to the regular swimming class, the most obvious difference was the size of the class. It is recognized that smaller classes can be taught much more rapidly than large ones, and that there is more space for practice in the small classes. Careful organization of a large class can meet this difference. Proper planning permits each group or individual to proceed as rapidly as possible. Too frequently swimmers are held back waiting for slow ones.

Results

It is believed that this group of 20 swimmers shows all the characteristics of ability and reaction to swimming to be found in any class with the exception of the highly pathological fear cases. The latter are usually segregated for instruction when found in classes. In this case they were segregated as nearly as possible before starting, though several of the cases showed marked fears and persistent fears well into the series of lessons.

The results of this study are almost identical with a similar one conducted previously by Kuhl (4).

The following conclusions are based on the performance of these 20 cases.

1. The average learning time for swimming perfected to the level represented by this 15-min. test is 5½ hr. distributed in half-hour lessons.
2. Evidence is inadequate to compare the learning resulting from 2-, 3-, and 4-day-per-week practice.
3. There is some indication that motor ability is one factor determining learning rate. It is not sufficient to counteract all other influences.
4. Accomplishments in the first lesson may be used to predict probable learning rate.

PART II

Procedure

Subjects in this part of study were regular enrollees of swimming classes the year after Part I was carried out.

Time in the water varied in different lessons and at various time from as little as 30 min. to 45 or 50 min. in some cases. The swimmers were classified as Beginners or Elementary. Beginners were defined as non-swimmers, completely inexperienced. Elementary swimmers had had a little experience, but skills were inadequate to pass the 15-min. test. The first three sections had no preliminary classification made, but were found to be almost entirely beginners. Records were taken once a week rather than daily, thus giving only an approximation of learning. No records were kept the first week. If a girl was out of the water one day no recognition of that fact was made on her achievement record. When she was out for the second time, the adjustment of one week was made. One week adjustment was made in her record for each additional two absences from the water.

Several different instructors participated in this project. Lesson plans were all similar to those in the Appendix (page 99) though no attempt was made to secure absolute conformity.

Discussion

Table 4 gives the comparison of sections on the basis of time in which they were checked on the test items. Based on these figures, the following summary is outlined.

TABLE 4

Swimming Achievement in Terms of Percentage Completing Each Item and Mean Time Required for Those Passing

N	11		38		41		44	
Instructors	A		A & B		A & C		A & C	
Frequency of lessons	4 day/wk.		2 day/wk.		2 day/wk.		2 day/wk.	
Time in the water per lesson	30 min.		50 min.		30 min.		30 min.	
Test	Beg.		Beg.		Beg.		Elem.	
	%	M[1]	%	M[1]	%	M[1]	%	M[1]
Face float and recovery	100	2.0	100	2.1	100	2.2	100	2.3
Back float and recovery	100	2.0	100	2.8	88	2.8	98	2.4
Flutter kick	82	2.0	97	2.3	83	3.4	100	2.4
Backstroke across	100	2.3	97	2.6	78	3.3	98	2.4
Backstroke length	82	2.3	95	3.0	78	3.8	98	3.2
Treading form	100	2.5	78	3.0	61	4.2	100	2.6
Treading 30 sec.	100	3.1	76	3.1	54	8.8	98	2.7
Treading 60 sec.	91	3.1	74	3.4	49	4.0	95	2.7
Treading 90 sec.	91	3.1	76	3.6	49	4.1	98	2.8
Treading 120 sec.	91	3.1	74	3.5	54	4.4	98	3.0
Sitting dive	91	2.8	87	3.0	68	4.3	80	2.8
One arm side across	100	3.5	87	3.6	41	4.6	89	2.9
One arm side length	91	3.2	78	3.6	32	4.9	86	3.5
Two arm side across	100	3.5	84	3.7	48	4.8	70	3.6
Two arm side length	91	3.4	76	3.6	61	5.3	100	3.3
Change direction/deep	91	3.1	78	3.1	39	5.4	100	4.0
Change position/deep	91	3.4	74	3.4	41	4.9	98	4.0
Standing dive	91	3.5	71	3.6	37	5.1	93	3.6
Change position sequence	91	3.5	74	3.8	24	4.2	95	4.1
15-min. test	91	3.5	63	4.3	37	5.7	93	4.6
Knowledge:								
Md.		24.0		25.5		27.0		28.0
M		24.6		25.1		26.6		27.0
σ		3.3		3.5		4.8		2.9

[1]All results are in units of weeks required. No testing first week.

(a) Most of the members of the class can be expected by the end of the third week to do all preliminaries, swim backstroke the length, do sitting dive, do some treading.

(b) Within the fourth week, the majority will extend treading to two minutes, swim a sidestroke the length, change direction and position in deep water, and do a standing dive.

(c) One to two weeks' additional practice is adequate for most of the class to perfect strokes and to develop endurance to pass the 15-min. test.

(d) There is great individual variation in learning rate. [By the end of the third week, 14 of the 90 beginners had passed the 15-min. test (16%) and 15 of 44 ele-

mentary (34%) had passed.] The majority of students can learn more rapidly than skills can conveniently be presented in large divergent classes.

(e) There is some indication, from the standpoint of learning rate, that the four half-hour periods constitute a more satisfactory schedule than either of the other two. (Number of cases is small, however.)

(f) There was a rather marked resemblance between the learning rate in these classes and that of the smaller groups in the previous study.

Certain things are not revealed by these figures, however. No testing was done the first week, and first items could have been done much more rapidly than indicated here. Attendance was erratic and weekly records do not reflect, therefore, the true learning curve. So-called "elementary" swimmers could not be checked rapidly enough to indicate accurately their achievement rate.

It was observed that when treading form is achieved, endurance follows almost immediately. When deep-water competence is established, the swimmer progresses promptly into continuous swimming as represented by the 15-min. test. The swimmers showed a real interest in their achievement records. The achievement chart used in this study proved a workable progression for the classes. (See Table 4.)

As a result of the above findings and observations made in classes, the swimming committee conducting this investigation made the following recommendations relative to swimming instruction.

1. Segregate beginners and non-beginners when possible.
2. Provide adequate help to care for slow learners in order to avoid handicapping the majority of the class.
3. Accelerate time schedule for presentation of skills to enable class to learn new skills while still perfecting others.
4. Introduce swimmers to deep water and safety skills, i.e., treading, change of position and direction, at the earliest possible moment. (This means second or third lesson.)
5. Keep achievement records regularly as an incentive to students and a means of directing student effort when the instructor is otherwise busy.

Conclusions

The following conclusions are based on the findings of the two parts of this study.

1. The great majority of swimmers can be taught sufficient swimming skill to pass the 15-min. test in an eight weeks term (15-16 lessons) or less.
2. It has been demonstrated that swimmers can be introduced successfully to deep-water skills in the very early stages of learning. (Second or third lesson.)
3. Individual learning rates differ markedly.
4. Class achievement is very similar to that of the small groups. The difference between the two can be kept to a minimum by careful organization and progression. The organization of the class for practice and for recognition of achievement may be a handicap to student progress.

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APPENDIX

Progression

Lesson 1. Breathing, floats and recovery, backstroke.
Lesson 2. Backstroke, turning over.
Lesson 3. Review, vertical float in deep water, backstroke length of pool.
Lesson 4. Review, treading. (Sidestroke for few who were ready.)
Lesson 5. Review, deep-water change of position, sidestroke.
Lesson 6. Review, sidestroke length.
Lesson 7. Review, sidestroke, more than one length, continuously if possible, diving.
Lesson 8. Review as needed or new skills added if slow learners have not tried previously. Develop endurance by continuous, relaxed swimming.

(Submitted 4-1-52)

Relation of Breakfast Regimen to Control of Body Weight

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Abstract

Data were collected from school boys, young women, young men and elderly men relative to the effect of the breakfast regimen on control of body weight. The data showed that omission of breakfast was ineffective in weight-reducing regimens, and that the most effective way to control weight was to gear the daily food intake to each individual so that he eats more, less, or the same amount of food necessary for daily energy requirements. It was also found that the nutritional principles involved applied to all ages and both sexes alike.

THE FACT THAT people who are overweight have a life expectancy which is significantly less than those who are of normal weight, and are at the same time at an efficiency disadvantage, has stimulated tremendous interest in the question of the control of body weight. A natural consequence of this increased attention to body weight is the appearance of many plans which claim to solve the problem. The result is that there is considerable confusion because of such a wide variance in recommended procedures.

The most unfortunate feature of most of the plans which are proposed is that no account is taken of the fact that weight reduction is an individual experimental procedure, which if not conducted properly may lead either to disastrous results or, at best, put the reducer to an unnecessary physical disvantage. Certainly all are agreed that weight reduction involves more than nutrition and should be undertaken only at the advice of a physician and under the close supervision of a nutritionist or dietitian.

In order to avoid the abuse, fads, and misinformation which are so prevalent, nutritionists and dietitians have planned effective low calorie diets, which within themselves can be used with impunity in a weight reduction program. The nutritionists and dietitians who have constructed low calorie diets make no claims, and rightly so, that any diet which they propose applies to everyone. If a weight reduction plan is to be pursued to the best advantage of the individual concerned, supervision as to amount and content of the diet, rate of weight loss comparable with resistance, and energy demand, and the desired weight to be attained and maintained must be under the supervision of a physician as well as an adequately trained nutritionist or dietitian, all well versed in the fundamental principles involved in weight control regimens. Thus, any unsupervised plan in the hands of the laity should be discouraged.

[1]This work was generously supported by a research grant from the Cereal Institute, Inc., Chicago, Illinois.

Purpose of the Study

It is the purpose of the investigation reported here to throw some light on the question of the influence which the breakfast regimen has on the body weight. During the course of nutritional experiments which covered a five-year period, an opportunity presented itself for studying body weight changes both of male and female subjects who were in good health, covering a wide age range, during several breakfast regimens when the total daily caloric intake was rigidly controlled. Data were also collected to show the effect on the body weight of omitting breakfast, when the total daily food intake was unrestricted.

Although it is generally agreed that an adequate breakfast is essential for the most efficient late morning performance, there are some overweight people who either unwillingly or willingly omit the morning meal because of their mistaken belief that such procedure will result in an appreciable loss in body weight. It has been shown recently that all diet plans should include breakfast, unless there is some specific clinical reason for not doing so. It has been demonstrated by Tuttle, Daum, et al. (6, 7, 10) that the omission of breakfast results in a reduction of mental and physical efficiency in the late morning hours as attested by the fact that neuromuscular tremor magnitude may be increased, reaction time may become longer, capacity to do work is decreased, as are both maximum grip strength and strength endurance.

Also, it has been reported by Daum, Tuttle, et al. (4) and Tuttle, Daum et al. (8, 9) that, although the amount of food does make a difference, the different combinations of customary breakfast items, such as cereal and milk, and bacon and eggs, are equally effective in performing the functions of a good breakfast. It has been concluded that a morning meal consisting of customary breakfast items which provides one-fourth to one-third the daily protein and caloric needs is more conducive to physical fitness and mental alertness than a larger meal which provides as much as 40 per cent of these items.

In addition, it has been shown by Bryant, et al. (2), Coleman, et al. (3) and Addison, et al. (1) that an adequate amount of protein in the morning meal is important in keeping the blood sugar from falling below the fasting level in the late morning hours. These investigators also reported that whether the protein is from plant or animal sources is unimportant, since adequate plant protein was as effective as adequate animal protein in the maintenance of the blood sugar level following breakfast.

The breakfast regimens studied were as follows:

1. *Free choice of food.* Under this circumstance, all subjects were permitted to pass through the cafeteria line and select whatever available items desired and as much of them as they wished.

2. *Basic cereal and milk breakfast.* This breakfast consisted of fruit, cereal, milk, bread and butter, and supplied approximately one-fourth the daily caloric need together with one-fourth the daily protein allowance.

3. *Omission of breakfast.* No food was allowed after 7:00 P.M. on the previous day.

4. *Basic bacon and egg breakfast.* This breakfast was built around bacon and eggs and provided approximately one-fourth the total daily caloric and protein requirements.

5. *Heavy breakfast.* This breakfast furnished approximately 40 per cent of the total daily caloric and protein requirements.

The various groups studied were as follows:

1. Boys 12-14 years of age.
2. Women 18-25 years of age
3. Men 20-35 years of age
4. Men 60-83 years of age

Procedure

At the beginning of each nutritional experiment each group of subjects, whose total daily food intake was to be rigidly controlled, was fed a diet of their own selection in the University Hospital cafeteria, under the supervision of a dietitian. During this preliminary period of free food choice, an opportunity was given the dietitian to observe and study the eating habits of the subjects so that she was better able to construct menus suitable to the likings of the subjects for the periods which were to follow, when the total diet was to be completely controlled. Since the subjects were involved in other nutritional and physiologic experiments, advantage was taken of the preliminary period to teach them the various techniques required for the experiment. During this and all subsequent breakfast periods, which followed in the sequential order previously stated where the breakfaest regimens were described, body weight without clothing was determined twice each week, on the same day of the week and at the same hour of day.

In the tables which follow, the weight given is to the nearest pound, and represents the last weight recorded previous to the changed breakfast regimen which followed immediately. The body weight data for the various breakfast regimens are discussed on the basis of age groups.

Group 1—*Twelve to 14-year old boys.* Two experiments were carried out with this age group. The first experiment (A) involved 8 boys and was designed to show the effect of an altered breakfast regimen on body weight changes, when the total daily food intake was rigidly controlled. The second experiment (B) involved 18 boys and was planned to show the effect of the omission of breakfast on body weight changes when the boys were unrestricted as to diet except for omission of the morning meal.

A. *Controlled diet.* In this part of the experiment the total daily food allowances were calculated so that each boy, except one, had as much food as he desired. The exception, subject 7, was considerably overweight, and in accordance with his wishes and those of his parents, his caloric intake was restricted with the result that he lost weight during the experimental period.

TABLE 1

Body Weight Changes of Eight School Boys Between the Ages of 12-14 Years During the Breakfast Regimens as Indicated, Where the Total Daily Food Intake is Rigidly Controlled

Subject	Free choice period 2 weeks	Basic cereal and milk breakfast 4 weeks	No breakfast 2 weeks	Basic bacon and egg breakfast 4 weeks	No breakfast 2 weeks
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*
1	101	108	109	109	110
2	87	88	89	89	90
3	75	77	75	—	—
4	134	137	141	144	147
5	102	107	108	110	111
6	85	88	86	89	89
7	121	117	116	117	118
8	83	—	84	86	87

The data relative to the body weight changes during the altered breakfast regimens are shown in Table 1.

The body weight changes among the boys, as shown in Table 1, present several points of interest. Subject 3 suffered from an infectious disease and was dropped from the project. All the boys, except the one previously mentioned, gained weight consistently during the 16-week period. The weight gain of the six subjects varied from 3 to 13 lb., in spite of the fact that all of them were given as much food as they desired. The boy who gained most demanded the most food, which was allowed. He was extremely tall and thin for his age, so additional poundage was desirable.

It is of interest to note that the distribution of the food throughout the day had no significant influence on the body weights of the boys. This is in accord with the principle that the total amount of food eaten is the determining factor in the control of body weight. The data in Table 1 show that the content and spacing of the daily food intake is unimportant in the control of body weight, so long as the total daily caloric value of the food eaten is controlled.

B. *Unrestricted food except for breakfast.* In this part of the experiment the subjects followed their customary dietary habits and ate their food at home. The only restriction placed upon the diet involved breakfast. During the first three weeks, the boys were urged to eat a good breakfast. Each morning that they were tested they reported the approximate amount and the items included in their breakfasts. On the basis of this report, the dietitian calculated the amount of food eaten. The aim was to have each subject eat from one-fourth to one-third of the total daily food intake at the morning meal. During the three-week period which followed immediately, the subjects ate no food from 7:00 P.M. the previous day until noon the next day. The body weight changes on these plans are shown in Table 2.

The data show that 12 of the boys gained weight during the no-breakfast period. Two subjects lost one pound each and in four cases there was no change in weight during the three-week period. The data indicate that where

TABLE 2

Body Weight Changes of Eighteen School Boys Between the Ages of 12-14 Years During the Breakfast Regimen as Indicated, Where the Food Intake Was Unrestricted Except for the Morning Meal

Subject	Breakfast 3 weeks	No breakfast 3 weeks
	(lb.)	*(lb.)*
1	100	102
2	111	112
3	113	114
4	85	85
5	99	101
6	128	134
7	85	85
8	92	93
9	103	104
10	115	116
11	101	102
12	137	137
13	93	94
14	85	84
15	103	104
16	93	94
17	87	86
18	68	68

the food intake is unrestricted, the omission of breakfast is not conducive to body weight loss. In most instances, the subjects evidently made up in amount of food at lunch and dinner what was omitted in the morning. In one instance (Subject 6) there was evidently overcompensation, since he gained six pounds in three weeks.

Group 2—*Eighteen to 25-year-old women.* This experiment involved eight healthy women varying in age from 18 to 25 years. The dietary plan of this experiment was similar to that described for the 12 to 14-year-old boys, whose total daily food intake was controlled. All the subjects in this group, except subject 4, expressed a desire to maintain their poundage. Subject 4 expressed a desire to lose some weight during the course of the experiment. After a two-week preliminary period during which all the subjects were allowed a free choice of food, a diet regimen was constructed for each subject. The plan consisted of adjusting the total daily food intake so that each subject could acquire or maintain the desired body weight. The breakfast regimen was varied so as to determine if altering the amount and content of this meal had any influence on body weight changes. The data are presented in Table 3.

The data in Table 3 show in the case of all subjects except number 4 that there were no significant weight changes regardless of the breakfast regimen. Subject 4 experienced a planned gradual weight loss throughout the experiment, which is unrelated to the breakfast regimen but which was brought about by reducing the total daily food intake. The data indicate that the breakfast regimen had no influence on the control of the body weight, but the total daily caloric intake was effective in this respect.

TABLE 3

Body Weight Changes in Eight Women Between the Ages of 18 and 25 Years, During Breakfast Regimens as Indicated When the Total Daily Food Intake is Rigidly Controlled

Subject	Preliminary period 2 weeks	Basic breakfast period 5 weeks	No breakfast period 5 weeks	Coffee only 5 weeks	Heavy breakfast period 5 weeks
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*
1	150	150	149	148	149
2	142	143	142	142	143
3	120	121	120	119	120
4	150	148	145	142	140
5	120	120	121	122	122
6	136	138	137	137	137
7	155	151	151	152	152
8	115	114	114	115	114

Group 3—*Men 20 to 35 years of age.* Ten healthy men between the ages of 20 and 35 years took part in this experiment. The experimental procedure was similar to that previously described. There were no weight problems among the subjects, thus, the problem was one of adjusting the total daily caloric intake so as to maintain the initial body weight of all subjects. The data collected from the men are shown in Table 4.

TABLE 4

Body Weight Changes in Ten Men Between the Ages of 20 and 35 Years During Breakfast Regimens as Indicated When the Total Daily Food Intake Was Rigidly Controlled

Subject	Preliminary period 2 weeks	Basic cereal breakfast period 3 weeks	No breakfast period 3 weeks	Bacon and egg breakfast period 4 weeks	Heavy breakfast period 4 weeks
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*
1	150	148	146	146	147
2	155	156	155	155	155
3	155	155	154	154	153
4	162	160	160	160	160
5	170	170	168	167	167
6	140	145	140	140	141
7	176	177	175	174	175
8	169	170	167	167	166
9	187	186	187	188	187
10	146	146	144	145	145

The data in Table 4 show that altering the breakfast regimen had no effect on the maintenance of the body weight of any of the subjects. The only effective adjustments were in the amount of food eaten each day.

Group 4—*Men 60 to 83 years of age.* There were eight subjects out of the group involved in the nutritional experiments from which complete body weight data were available. Although these men were well along in years, medical examination showed that they were physically fit for men of their age. The medical examination also showed that, among this group, there were two men who were overweight and one who was underweight. The daily diets were designed either to adjust or maintain the weight of the subjects through-

out the course of the experiment. Table 5 shows the body weight status of all the subjects throughout the experiment. As before, the total daily caloric intake was rigidly controlled, the only variable being the breakfast regimen and whatever adjustments were necessary in the amount of food required to produce the desired weight changes.

TABLE 5

Body Weight Changes of Eight Men Between the Ages of 60 and 83 Years, During the Breakfast Regimens as Indicated, When the Total Daily Food Intake Was Rigidly Controlled

Subject	Preliminary period 4 weeks	No breakfast period 4 weeks	Basic bacon and egg breakfast period 5 weeks	Heavy breakfast period 5 weeks	Basic cereal and milk breakfast period 4 weeks
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*
1	164	164	164	163	163
2	220	218	210	207	205
3	160	161	162	162	161
4	169	170	171	170	169
5	170	167	160	156	154
6	126	129	135	136	138
7	112	112	113	113	112
8	125	126	126	127	126

The data in Table 5 show that the prescribed diet maintained the weight of five subjects, regardless of the breakfast regimen. Subject 2 lost 15 pounds on the diet prescribed for him, while subject 5 lost 16 pounds. Subject 6, who was underweight, gained 12 pounds on the diet prescribed for him. Subjects 7 and 8 were small of stature and had not varied in weight for several years, so no attempt was made to have them gain weight. The data presented in Table 5 are evidence that one may alter the body weight by increasing or decreasing the total caloric intake, without regard to the breakfast regimen.

Discussion

In any diet regimen designed to alter body weight there are a number of important items which must be observed, if the plan is to yield the desired results successfully. The first point which the individual adopting any plan must recognize before beginning is that eating habits must be radically changed, and that to break any habit of long standing is a serious and difficult problem. A sound psychologic approach to an altered eating pattern must be established and maintained.

Before entering on a weight-reducing diet, the subject should be instructed as to the scientific facts established, and thus avoid running into such problems as decreased efficiency and the lowering of resistance to infectious disease. For example, few people should initiate a plan of drastic food reduction when they are to be under the stress of hard physical labor. Likewise, such a plan should not be initiated during any time when conditions are specially conducive to the acquisition of infectious diseases such as the common cold.

Another point which must be taken into account is the distribution of the daily food intake. There is a tendency to think that three regular meals per day are essential for men and children but not for women. Young women, especially, have a tendency to violate the important three-meal-per-day principle, with the idea that by so doing they are better able to control their body weight (5). The evidence is quite conclusive that the omission of the morning meal should never be practiced by anyone, especially those on a reducing diet. This is true because by so doing the individual not only places himself at a physical and mental disadvantage, but gains nothing in the way of weight reduction. There is some evidence that omitting breakfast tends to lead to overeating at the lunch and dinner meals.

Available data indicate quite conclusively that the principles which apply to weight control regimens are universal and apply to both sexes and all ages. As has been shown in the data presented, one either can lose weight or maintain weight as he chooses by merely controlling the total daily caloric food intake. Individual characteristics sometimes make it difficult to gain weight. However, the case included in this experiment responded well to the weight-gaining diet prescribed for him.

A basic breakfast which provides one-third to one-fourth of the total protein and caloric requirements has been proven best to meet the requirements for maintaining physical and mental efficiency in the late morning hours. The data presented show that in reality, the breakfast regimen, whether it is "no breakfast," heavy breakfast, or basic breakfast has no effect on the body weight so long as the total daily caloric intake remains the same for each breakfast regimen. It is also suggested by the data that the omission of breakfast, even when one is free to eat as much as desired at other times, is poor economy in a weight control plan.

In selecting breakfast, one should take into account the fact that it should contain not only one-fourth to one-third the total daily caloric and protein allowance but also essential vitamins and minerals. It is generally accepted that any combination of customary breakfast items which meets the nutritional requirements of a good breakfast is satisfactory. These nutritional requirements are met equally well either by a basic cereal and milk breakfast or a bacon and egg breakfast.

Summary and Conclusions

Data were collected from school boys, young women, young men and elderly men relative to the effect of the breakfast regimen on body weight. The data justify the following conclusions:

1. The omission of the morning meal is ineffective in a weight-reducing regimen. This is true regardless of whether the total daily food intake is rigidly controlled or left to the discretion of the individual.

2. The most effective way to control body weight is to gear the total daily food intake to each individual so that he eats more, less, or the same amount of food necessary to meet the energy required for the daily activities.

3. The nutritional principles involved in the control of body weight, considered in the experiment reported here, apply to all ages and both sexes, alike.

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(Submitted 7-1-53)

Physical Activity Experience and Interests of College Women

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Abstract

In this study, 267 Freshman college women recorded the extent of participation in physical activities during high school years. They indicated the activities they had liked or disliked and those which they wished to learn or to continue. It was found that three team sports dominated the high school years and that experience in rhythmic activities and individual sports was meager or lacking. However, the five most-liked activities were of the latter type, as also were ten of the 12 most frequently requested in the college program. Recommendations for adjustments in college offerings are included.

IN EVALUATING ITS program, the Women's Physical Education Department of Southern Illinois University sought information concerning the actual physical activity experiences, attitudes and interests of women students entering the university. The 267 Freshman women who had passed the physical examination and were recommended for regular physical education classes in the fall of 1952 were the subjects of this study.

When investigating the students' experiences, it was not only necessary to know in which activities they had participated, but also something of the extent of participation and the type of situation in which the activity occurred. Since attitudes are influenced by learning situations, it was considered helpful to know whether activities were learned in the physical education class or by participation outside the school, either with or without instruction.

In dealing with attitudes and interests, we wished to know which activities the students had liked and in which of these there remained sufficient interest for them to want to continue the activity during a part of college life. A statement of activities they disliked was also sought. Lastly, but of major importance, students were asked to designate the physical activities which they wished to learn in college.

Procedure

The subjects were given a questionnaire which had been checked for clarity and inclusiveness by trial with a class of Sophomore students. The questionnaire included a list of physical education activities in which American girls and women participate. Three columns were provided for recording participation. The first was designated for physical education class activities; the second, for school-sponsored activities which occurred outside class time; and the third, for activities in which the student participated outside the school. The extent of the experience was shown by the way in which the student marked the columns. A check mark indicated at least 16 sessions. For fewer

than 16, the student recorded the approximate number.[1] If out-of-school activities were sponsored by an organization, the name of the organization was recorded also.

Space was provided for the subject to indicate her attitude toward each activity which she had marked. A figure one (1) was used to show that she definitely liked the activity, a figure two (2) that she neither liked nor disliked it, and a figure three (3) that she definitely did not like the activity.

Next the subject marked those activities in which she had no experience but which she wished to learn. A figure one (1) was used for those activities she definitely wanted to learn and a figure two (2) for those she thought she might like to learn. Activities in which the student had experience and which she wanted to continue in college were marked by a check in the last column. Space was provided for the addition of any activity which was not included in the list.

Presentation and Interpretation of the Data

EXPERIENCE IN PHYSICAL EDUCATION ACTIVITIES DURING HIGH SCHOOL YEARS

Physical Education Class Activities. Activities in which students participated during their high school physical education classes are shown in the first five columns of Table 1. It can be seen from this table that softball, basketball, and volleyball predominated in the class programs, softball being reported by 99.3 per cent of all involved in the study. Basketball was played in the classes of 235 students (88.0%) and volleyball in those of 221 students (82.8%). These activities were not only part of the class programs for the greatest number of students, but the average number of seasons during which they were held, three and two-tenths, three, and two and nine-tenths respectively, exceeded those of any other activities.

Gymnastics and tumbling were next most frequently used and were followed by dancing and individual or dual sports. When investigating the responses further, it was found that 100 of the students in this study (37.5%) had no dance activities during their physical education classes. Fifty-six (21%) had no dancing at all during their high school years. Square dancing was the form of rhythmic activity most frequently used.

The fall field sports were given places of lesser importance in the programs. Soccer received more emphasis than speedball or hockey, soccer being a part of the program for 36.0 per cent of the subjects, speedball for 15.7 per cent of them and hockey for 15.4 per cent. One hundred thirty-one subjects (49% of those involved in the study) had no experience with any fall field sport.

One hundred twenty-two subjects (45.5% of the entire group) had none or less than one season of an individual or dual sport in their class programs.

Only 14 students (5.2%) were given instruction in swimming as a part of their class work, the average number of seasons being two and six-tenths.

[1]The writer has made use of the method of reporting participation described by Dorothy Beise in a study of the physical education background of students at the University of Michigan during 1937-39.

Extra-class School Activities. Participation in extra-class activities is presented in columns six through ten of Table 1. It is evident from this section of the table that basketball, volleyball, and softball—the three activities most frequently used in the classes—were also most popular in the extra-class programs. All other activities were reported much less frequently. Fourth on the list was table tennis, in which only 50 students (18.7% of the total number) participated.

Gymnastics, tumbling, soccer, and archery received less emphasis as extra-class activities than they had in the class programs. Hiking, roller skating, bowling, and riding were relatively more important in the extra-class program, as might be expected because of the facilities and/or time required for them. However, 73.4 per cent of the subjects reported none or less than one season of participation in any individual or dual sport in their extra-class programs.

Rhythmic activities were used much less frequently than were the team sports. As in the class programs, square dancing was the type of rhythmic activity most often used.

Out-of-school Activities. Columns 11 through 15 of Table 1 present the activities pursued away from the school and its supervision. Some of these activities were carried on during the summers as well as during the school year. Sometimes they were sponsored by organizations, but often they were carried out individually or in unsponsored groups.

As might be expected, the activities which were most frequently engaged in during the out-of-school program were those which could be performed alone or in small groups and which were adaptable to co-recreation. Swimming, which ranked 19th in the class programs and 14th in the extra-class programs, was the most popular of all in the out-of-school program, with 59.6 per cent of the subjects participating in it.

Dancing was more frequently found in the out-of-school activities than in the other two types of programs. The team games of softball, basketball, and volleyball, which headed both the extra-class and the class programs, were not as popular in the out-of-school program, ranking third, tenth, and 14th respectively. The comparatively higher rank of softball may be due to the fact that it is more frequently used as a corecreational sport, basketball not being as well adapted to this purpose and volleyball needing less commonly owned equipment.

A large proportion of the out-of-school activity was not sponsored by any organization, as is evident from the fact that, out of a total of 1,197 reports of out-of-school activities in Table 1, sponsoring organizations were named in only 396 cases. The organizations most frequently named were 4-H Clubs, community groups and churches. Softball, camping, square dancing, swimming, social dancing, hiking, and table tennis were the most popular activities. Little if any instruction was received in this part of the student's experience.

Additional Activities. Activities which students added to the questionnaire consisted of a few lead-up games such as kickball and batball, and the winter

TABLE 1

Physical Activity Experiences During High School Years

Physical Education Class Activities					Extra-class School Activities					Out-of-school Activities				
Activity	Students who had at least one season		Total Seasons	Average Seasons	Activity	Students who had at least one season		Total Seasons	Average Seasons	Activity	Students who had at least one season		Total Seasons	Average Seasons
	Number	Per cent				Number	Per cent				Number	Per cent		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1. Softball	265	99.3	852	3.2	Basketball	122	45.7	279	2.3	Swimming	159	59.6	394	2.5
2. Basketball	235	88.0	714	3.0	Volleyball	101	37.8	223	2.2	Skating (roller)	120	45.0	239	2.0
3. Volleyball	221	82.8	650	2.9	Softball	86	32.2	149	1.7	Softball	110	41.2	211	1.9
4. Gymnastics	143	53.6	399	2.8	Table tennis	50	18.7	88	1.8	Social dance	105	39.3	245	2.4
5. Tumbling	133	49.8	289	2.2	Square dance	41	15.4	63	1.5	Table tennis	83	31.2	148	1.8
6. Square dance														
7. Badminton	126	47.2	213	2.5	Social dance	33	12.4	57	1.7	Hiking	80	30.0	137	1.7
8. Table tennis	112	41.9	216	1.9	Badminton	32	12.0	53	1.7	Square dance	68	25.5	132	1.9
	106	39.7	218	2.1	Bowling	28	10.5	31	1.1	Bowling	59	22.1	94	1.6
9. Soccer	96	36.0	224	2.3	Hiking	28	10.5	44	1.6	Camping	59	22.1	123	2.1
10. Social dance	76	28.5	136	1.8	Skating (roller)	21	7.9	36	1.7	Basketball	58	21.7	94	1.6
11. Folk dance	75	28.1	129	1.7	Tumbling	18	6.7	28	1.6	Riding	56	21.0	90	1.6
12. Modern dance	54	20.2	72	1.3	Gymnastics	15	5.6	25	1.7	Tennis	47	17.6	88	1.9
13. Tennis	43	16.1	79	1.8	Tennis	15	5.6	23	1.5	Badminton	46	17.2	70	1.5
14. Speedball	42	15.7	93	2.2	Swimming	12	4.5	30	2.5	Volleyball	32	12.0	54	1.7
15. Hockey	41	15.4	95	2.3	Folk dance	12	4.5	15	1.3	Horseshoes	26	9.7	39	1.5

TABLE 1 (Continued)

Physical Activity Experiences During High School Years

Physical Education Class Activities					Extra-class School Activities					Out-of-school Activities				
Activity	Students who had at least one season		Total Seasons	Average Seasons	Activity	Students who had at least one season		Total Seasons	Average Seasons	Activity	Students who had at least one season		Total Seasons	Average Seasons
	Number	Per cent				Number	Per cent				Number	Per cent		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
16. Archery	34	12.7	48	1.4	Modern dance	8	3.0	8	1.0	Folk dance	20	7.5	33	1.7
17. Hiking	23	8.8	33	1.4	Hockey	7	2.6	12	1.7	Lifesaving	11	4.1	18	1.7
18. Horseshoes	20	7.5	27	1.4	Soccer	7	2.6	14	2.0	Tumbling	11	4.1	18	1.7
19. Swimming	14	5.2	36	2.6	Speedball	5	1.9	8	1.6	Archery	10	3.7	13	1.3
20. Trampoline	12	4.5	20	1.7	Horseshoes	5	1.9	5	1.0	Tap dance	10	3.7	27	2.7
21. Tap dance	12	4.5	15	1.3	Riding	3	1.1	4	1.3	Golf	8	3.0	9	1.1
22. Skating (roller)	10	3.7	27	2.7	Trampoline	3	1.1	3	1.0	Modern dance	6	2.2	9	1.5
23. Bowling	8	3.0	9	1.1	Tap dance	3	1.1	10	3.3	Gymnastics	5	1.9	11	2.2
24. Fieldball	6	2.2	10	1.7	Archery	2	.8	4	2.0	Fencing	2	.8	2	1.0
25. Golf	4	1.5	4	1.0	Camping	2	.8	2	1.0	Trampoline	2	.8	2	1.0
26. Camping	3	1.1	5	1.7	Golf	2	.8	3	1.5	Hockey	1	.4	1	1.0
27. Lifesaving	3	1.1	5	1.7	Fieldball	1	.4	1	1.0	Soccer	1	.4	2	2.0
28. Riding	3	1.1	5	1.7	Lifesaving	1	.4	2	2.0	Speedball	1	.4	3	3.0
29. Ballet	3	1.1	3	1.0	Fencing	0	0.0	0	0.0	Ballet	1	.4	3	3.0
30. Fencing	0	0.0	0	0.0	Ballet	0	0.0	0	0.0	Fieldball	0	0.0	0	0.0
Total	1923		4626			663		1220			1197		2309	

sports of skiing and ice skating which are not adaptable to southern Illinois climatic conditions. The small number and the limited kinds of activities added seem to indicate that the questionnaire was adequate.

Participation in Activities for Less Than One Season. The greatest number of reports of participation for less than one season's duration occurred in basketball, softball, and volleyball. When these reports were added to the reports of full seasons of participation in each of these sports, basketball and softball were found to be a part of the experience of every student. Volleyball was played by 88 per cent of the subjects. Fewer than ten students reported less than one season of participation in any of the 28 remaining activities and fewer than five in 22 of them. It seems possible that these experiences are unimportant since very few students were involved in them and since the activities most frequently reported were among those in which other students had reported several seasons of experience.

Attitudes Toward Physical Education Activities. To ascertain attitudes toward activities experienced during high-school years, the number of times each attitude was marked for a particular activity was totaled. In order to make a comparison among activities, this number was expressed as a percentage of the total number of subjects who had recorded an attitude toward that activity. Those in which attitudes were marked by 45 or more students are presented in Table 2. The remaining activities, which were marked by less than 25 students, were considered of too little value to be included. In Table 2 the activities are listed in order of the magnitude of the percentage of students who liked them. The numbers and percentages of students who recorded neither liking nor disliking the activity are also given in Table 2, as are the numbers and percentages of those who disliked the activity.

The writer had taken into consideration the fact that some of the activities had been chosen by the students while others were taken as part of a required program. It is to be expected that favorable attitudes will predominate in student-selected activities. However, the purpose of investigating student attitudes was merely to find out which activities were liked and which disliked. Therefore, the question of selection or requirement is unimportant.

From Table 2 it can be seen that swimming was liked by 83.4 per cent of the 157 students who expressed an attitude toward it. Social dancing and bowling ranked next in favor, with slightly more than 77 per cent liking each. Tennis, camping, riding, basketball, roller skating, and volleyball were favored in the order stated. Other activities liked by at least half those recording an attitude toward them were table tennis, square dancing, badminton, hiking, softball, archery, and folk dancing. Quite a drop is seen in the percentage of students expressing a liking for the last four activities, modern dancing being liked by 32.0 per cent, tumbling by 31.5 per cent, soccer by 25.0 per cent, and gymnastics by 22.8 per cent.

While the highly-organized team games of basketball and volleyball were well liked, six other activities were liked by a greater percentage of students. All six of these sports are of the individual or small group type and many

TABLE 2

Attitudes of Students toward Physical Education Activities Participated in During High School Years

Activity	Number expressing an attitude toward the activity	Liked the Activity		Neither Liked nor Disliked it		Disliked the Activity	
		No. of Students	Percentage	No. of Students	Percentage	No. of Students	Percentage
1. Swimming	157	131	83.4	25	15.9	1	0.7
2. Social dance	158	123	77.8	32	20.3	3	1.9
3. Bowling	102	79	77.4	20	19.7	3	2.9
4. Tennis	79	60	75.9	19	24.1	0	0.0
5. Camping	74	56	75.7	16	21.6	2	2.7
6. Riding	68	51	75.0	14	20.6	3	4.4
7. Basketball	256	188	73.4	54	21.1	14	5.5
8. Skating	167	117	72.2	40	24.7	5	3.1
9. Volleyball	242	166	68.6	64	26.4	12	5.0
10. Table tennis	171	102	59.6	61	35.7	8	4.7
11. Square dance	183	106	57.9	68	37.2	9	4.9
12. Badminton	168	95	56.5	67	39.9	6	3.6
13. Hiking	139	76	54.7	54	38.8	9	6.5
14. Softball	254	138	54.3	81	31.9	35	13.8
15. Archery	50	27	51.9	20	38.5	5	9.6
16. Folk dance	106	53	50.0	43	40.6	10	9.4
17. Speedball	45	21	46.7	16	35.5	8	17.8
18. Hockey	46	21	45.7	17	37.0	8	17.4
19. Modern dance	72	23	32.0	34	47.2	15	20.8
20. Tumbling	143	45	31.5	59	35.6	47	32.9
21. Soccer	104	26	25.0	65	62.5	13	12.5
22. Gymnastics	162	37	22.8	73	45.1	52	32.1

are adaptable to corecreation. It would seem then that students like best swimming, social dancing, tennis, bowling, camping, basketball, roller skating, and volleyball since there was a drop of 9 per cent before the next most liked activity.

Probably the most interesting item to be found in the columns showing the number and percentage of students who reported that they neither liked nor disliked an activity was the large percentage (62.5%) who marked soccer in this manner.

In the last two columns of Table 2 it will be seen that tumbling and gymnastics were the activities most often reported as disliked by those expressing attitudes toward them. Because of the similarity of these two activities, it might be expected that the attitudes toward them would be similar. Very few students disliked bowling, camping, and swimming, and no one reported a dislike for tennis.

Activities Students Desire to Learn. In Table 3, the activities students wish to learn in college are listed in order of the number of students desiring

them. The first and second columns give the number and percentage of students who indicated that they would like to participate in the activity in college. The third and fourth columns represent, respectively, those who think they have attained at least a slight degree of skill in the activity and those who consider themselves inexperienced in it. The last column expresses the number who were inexperienced in the activity as a percentage of the total number desiring to learn it.

From Table 3 it can be seen that tennis is in greatest demand, 197 or 73.8 per cent of the total of 267 students having requested it. Basketball and volleyball were the only team games appearing among the first 12 activities

TABLE 3

Activities Students Wish To Continue or To Learn at College

Activity	No. Requesting the Activity	Percentage of Subjects Requesting it	No. Who Considered Themselves Experienced in it	No. Who Considered Themselves Inexperienced in it	Percentage of Those Requesting it Who Were Inexperienced in it
1. Tennis	197	73.8	50	147	74.6
2. Basketball	189	70.8	178	11	5.8
3. Swimming	183	68.5	96	87	47.5
4. Bowling	180	67.4	61	119	66.1
5. Golf	166	62.2	11	155	93.4
6. Volleyball	162	60.7	152	10	6.2
7. Archery	161	60.3	26	135	83.8
8. Social dance	141	52.8	92	49	34.8
9. Riding	128	47.9	31	97	75.8
10. Badminton	123	46.1	79	44	35.8
11. Skating	116	43.4	72	44	37.9
12. Square dance	113	42.3	77	36	31.8
13. Hockey	112	41.9	27	85	75.9
14. Softball	110	41.2	104	6	5.5
15. Table tennis	101	37.8	75	26	25.7
16. Modern dance	88	33.0	24	64	72.7
17. Fencing	87	32.6	2	85	97.7
18. Life saving	80	30.0	25	55	68.8
19. Tap dance	79	29.6	14	65	82.3
20. Trampoline	78	29.2	6	72	92.3
21. Speedball	69	25.8	27	42	60.9
22. Folk dance	63	23.6	33	30	47.6
23. Soccer	56	21.0	27	29	51.8
24. Tumbling	55	20.6	39	16	29.1
25. Camping	43	16.1	21	22	51.2
26. Hiking	41	15.4	27	14	34.1
27. Gymnastics	39	14.6	26	13	33.3
28. Fieldball	35	13.1	1	34	97.1
29. Horseshoes	30	11.2	8	22	73.3
30. Deck tennis	7	2.6	6	1	14.3
31. Track	3	1.1	2	1	33.3

requested. The ten others were of the individual or dual type. They included tennis, swimming, bowling, golf, archery, social dance, riding, badminton, roller skating, and square dancing. These were followed by hockey, a sport new to 75 per cent of those requesting it and softball, a sport with which all but six students considered themselves experienced.

Conclusions and Recommendations

Physical education classes provided the greatest part of the physical activity experiences of the subjects in this study during their high school years. While all but 18 students reported participating in activities away from school, the number of seasons of such participation was much less than in the class programs.

Softball, basketball, and volleyball dominated the class and extra-class programs. All other activities were experienced by a much smaller number of students and for fewer seasons. From the standpoint of the amount of previous experience in these sports as compared with that in other activities, it would seem wise to de-emphasize them in the college program. While they are needed in the program for those who have a continuing interest in them, as well as for those who are inexperienced with them, the needs and interests of most students would be better met by other forms of activity.

Approximately half the group had no experience with the fall field sports. Students should be encouraged to include hockey, speedball, or soccer in their college program.

Many students received no instruction in any individual or dual sports during their high school years. Because of this fact and since a great majority of the subjects in this study have expressed a desire for these activities, more instruction should be provided in them and a greater variety of these sports should be included in the program. First consideration should be given to the most requested of these activities, swimming, bowling, and tennis.

The rhythmic activity experiences of these students were meager. Over 37 per cent of the subjects had no dancing in their physical education classes, and, for those who did, the average number of seasons of participation was approximately one-half as great as for softball or basketball. Square dancing was the most frequently used form of dancing in the classes. The most popular rhythmic activity carried on away from school was social dancing, in which 40 per cent of these students took part. In the college program, rhythmic activities should play an important part and emphasis should be placed on forms of dancing other than square dancing.

The implications of this study concern both high school and college physical education programs. The following suggestions are made for revision of programs of the many schools in which student experiences are similar to those found in this study: (1) that the opportunities for the learning of tennis be greatly increased; that sufficient courts and indoor facilities be obtained to permit the teaching of many more tennis classes; (2) that swimming classes be scheduled as early in the program as possible and that there be

a sufficient number of classes to make it possible for every student to receive instruction; (3) that bowling be included in the girls and women's program; (4) that there be increased opportunities for classes in golf and archery; (5) that students be encouraged to participate in a greater variety of dance forms; (6) that students be given more experience with fall field sports rather than concentrating on basketball, volleyball, or softball; (7) that plans be set up to assist students to learn riding at their own expense; and (8) that since the recreational aspect of individual and dual sports is important, coeducational classes in these activities be scheduled.

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3. Hazelton, Helen W., and Junerose Piper. A Study of the Social Values of a Team Game and of Two Individual Sports as Judged by the Attitudes of Freshman College Women. *Research Quarterly*, **11**: 54-59 (May 1940).

(Submitted 6-3-53)

Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, PAUL A. HUNSICKER, Chairman

Anatomy and Physiology

1. ADDISON, V. E., *et al.*, The effect of amount and type of protein in breakfasts on blood sugar levels, *Journal of the American Dietetic Association.* **29**: 674-7 (1953).

Blood sugar levels were observed in 14 subjects for 3½ hours following breakfasts containing either animal protein (approximately 15 grams) plus fat and carbohydrates, or plant protein (approximately 15 grams) plus fat and carbohydrates. There was no significant difference in the blood sugar curves following the two types of breakfasts when determinations were made every 30 minutes for the 3½ hr. The blood sugar level was maintained significantly above the fasting level for only the first 60 min. after breakfast. Beyond this time, the level of sugar in the blood was not significantly different from the fasting level.—*Henry J. Montoye.*

2. ASTRAND, P. O. Study of bicycle modifications using a motor-driven treadmill bicycle ergometer. Arbeitsphysiologie, **15**: 1 (May 1953).

Different types of bicycles were studied to determine the energy output for varying distances and speeds. The ordinary bicycle ergometer does not take into consideration type of tire and distance between wheels. Information concerning length of pedal crank and gear ratio was also considered. A treadmill-bicycle ergometer was employed for the experiments. The author found that oxygen intake during cycling was not altered by either different length in pedal crank or by different head angles (angle between top tube and front fork), that the quality and dimension of the tires affected oxygen intake, and that working efficiency could be improved by changing the gear ratio.—*Frank D. Sills.*

3. BROZEK, JOSEF, To be or not to be—fat (and how to tell if you are), *Journal of the American Dietetic Association*, **29**: 344-5 (1953).

In this non-technical article, the author discusses the limitations of "Tables of Average Weights." Despite the crudeness of techniques for classifying individuals as overweight or underweight, recent mortality statistics (1950) based upon 25,998 men and 24,901 women support the earlier studies, indicating that overweight people tend to die prematurely.

Several techniques for evaluating the nutritional status (that is, whether or not there is excess fat) are discussed. The author concludes that more refined techniques in weight analysis will permit individual interpretations, as well as give the group trends.—*Henry J. Montoye.*

4. COLEMAN, M. C., W. W. TUTTLE, AND K. DAUM, Effect of protein source on maintaining blood sugar levels after breakfast, *Journal of the American Dietetic Association*, **29**: 239-44 (1953).

Blood sugar levels were observed for 3½ hr. in 13 subjects, following breakfasts containing either animal protein (approximately 25 grams) plus fat and carbohydrates, or plant protein (approximately 25 grams) plus fat and carbohydrates. Determinations of blood sugar level were made every thirty minutes. Breakfasts containing plant and animal protein were equally effective in maintaining blood sugar above the fasting level. Even 3½ hr. after breakfast, blood sugar was still above the fasting level. Breakfasts containing a combination of animal and plant protein were also just as effective in maintaining the blood sugar level.

The results of this study were compared with those of two previous investigations. The results were comparable in the three studies.—*Henry J. Montoye.*

5. GARN, STANLEY M., Individual and group deviations from "channelwise" grid progression in girls. *Child Development*, **23**: 193-206 (1952).

Two groups of girls, 32 in the first and 65 in the second, were used in this study. The first consisted of those who had been followed from birth on, and was used to investigate constancy of channel position between the 6th and 16th years of life. The second group of girls was followed for 2 to 4 years and was included to explore one-year changes in channel position and changes at different age levels. In the longitudinal series, the proportion of girls still in the starting channel dropped to 50% after one year, 19% after two years, and at no time thereafter exceeded 30%. In the short-term series, over 50% deviated one or more channels in a one-year period, and 9% deviated two or more channels. It was concluded that constancy of channel position is not a usual phenomenon in girls.—*Psychological Abstracts.*

6. KARPOVICH, P. V., AND C. J. HALE. Modified pole-top method of artificial respiration. *J. Applied Physiol.*, **5**: 723-24 (May 1953).

The new method is a double-phase one. The rescuer places himself behind the victim and puts his arms around the victim's chest. For expiration, he compresses the chest. For inspiration, the operator slightly spreads his arms and moves them upward, lifting the upper arms of the victim. The pulmonary ventilation obtained with this method is 1286 cc. per respiration. The article contains two figures illustrating this method.—*Peter V. Karpovich.*

7. KARPOVICH, P. V., AND C. J. HALE. Artificial respiration adapted to special conditions. *J. Applied Physiol.*, **5**: 717-22 (May 1953).

Pulmonary ventilation during 14 different methods of artificial respiration was measured on 15 conscious, nonapneic subjects. These methods were selected for their adaptability to special conditions when there is no room for the application of the H. Nielsen method: foxhole, trench, submarine, helicopter, plane, etc. The article contains illustrations of each method and the description of a new technique for measuring pulmonary ventilation.—*Peter V. Karpovich.*

8. MAHADEVA, K., R. PASSMORE, AND B. WOOLF. Individual variations in the metabolic cost of standardized exercises: the effects of food, age, sex, and race. *Journal of Physiology*, **121**: 225-231 (Aug. 1953).

The energy expenditures of 50 subjects were studied during a stepping exercise and walking. The subjects were of varying age, size, sex, and race.

The analysis of data revealed a linear relationship between metabolic cost and body weight. The prediction of metabolic cost from body weight is not materially increased in precision by consideration of height, age, sex, race, or resting metabolism.

Regression equations for predicting energy expenditure from body weight are given for both stepping and walking.—*Marjorie Phillips.*

9. ROCHE, A. F. Increase in cranial thickness during growth. *Human Biology*, 25:2, 81-92 (May 1953).

Serial radiographs of 32 white American children between ages of 3 months and 17 years were taken. The average male cranial thickness exceeded the female except at the euryon. Rate of increase in thickness was reduced after 5 years of age but continued to increase slightly until 17 years, except that no incerase was recorded for females at naison after 15 years and at euryon after 12 years of age. Females reached a greater percentage of 17-year average thickness at any age than did males.—*D. B. Van Dalen.*

10. SAUNDERS, J. B., VERNE T. INMAN, AND HOWARD D. EBERHART. The major determinants in normal and pathological gait. *J. of Bone and Joint Surg.*, 35-A, No. 3 (July 1953).

A glass walkway was used to study the displacements of the extremities in the three planes of space simultaneously. Displacements in the sagittal plane were also obtained by an interrupted light technique. The transverse rotations of the limb segments were determined by the insertion of pins into the bones. High-speed motion-picture photography,

electromyography, and force plates as well as other special techniques were also employed.

It was observed that human locomotion is a complex phenomenon and that a unifying principle is needed to study the individual motions occurring simultaneously in the three planes of space. For this reason, the concept that locomotion is the translation of the center of gravity through space along a pathway requiring the least expenditure of energy was adapted. This concept made possible a qualitative analysis in terms of the essential determinants of gait which included pelvic rotation, pelvic tilt, knee and hip flexion, knee and ankle interaction, and lateral pelvic displacement.

Irregularities in these determinants provided insight into individual variation and a dynamic assessment of pathological gait. Pathological gait was viewed as an attempt to preserve as low a level of energy consumption as possible by exaggerations of the motions at unaffected levels. The loss of one determinant (that of the knee is most costly) may be compensated, but the loss of two makes compensation impossible and the cost of locomotion in terms of energy is increased threefold.—*Frank D. Sills.*

11. Simonson, Ernst, and Josef Brozek. Flicker fusion frequency: background and applications. *Physiological Reviews*, **32**: 349-78 (1952).

A survey is presented of the data relating to values of CFF under varying conditions. The results are summarized from studies using normal conditions and conditions of stress, fatigue, narcotization, disease, and miscellaneous neurological lesions. The authors tend to view the critical locations of this function as being in the CNS rather than in the retina. 183-item bibliography.—*Psychological Abstracts.*

12. Swann, H. G., M. Gruger, and B. R. King. Assay of resuscitating procedures. *J. Applied Physiol.*, **5**: 421-28 (Feb. 1953).

Dogs were asphyxiated with pure nitrogen. When blood pressure showed a sudden collapse, one or the four methods of artificial respiration was applied: insufflation with CO_2 in O_2, positive and negative pressure insufflation, manual, and tilt board (Eve).

The positive and negative pressure insufflation was found to be the most effective. The mixture of 5% CO_2 in O_2 was better than pure O_2. The tilt board was less efficient than either of the two insufflations. The manual method was the least efficient because it did not produce sufficient pulmonary ventilation.—*Peter V. Karpovich.*

13. Swann, H. G., P. V. Karpovich, and D. B. Dill. Ineffectiveness of artificial respiration in rats after drowning. *J. Applied Physiol.*, **5**: 429-31 (Feb. 1953).

Thirty rats were submerged in fresh water until the end of struggle. Half of them were given manual artificial respiration—4 revived. The other half received no assistance—5 revived.

Examination of the lungs revealed that the respiratory passages of the rats which did not revive were filled with water and foam which blocked them completely.—*Peter V. Karpovich.*

14. Swann, H. G., P. V. Karpovich, and D. B. Dill. Effect of rigor mortis on tidal air in artificial respiration. *J. Applied Physiol.*, **5**: 277-80 (Dec. 1952).

Sixteen guinea pigs were used. Six were killed by pithing the medulla, 10 were drowned. In one-half of these animals pulmonary ventilation and pressure were measured during manual artificial respiration. In the other half, all the lungs were removed from the chest and the chest was made again airtight and the thoracic ventilation and pressure were measured during manual artificial respiration.

While in the animals with the intact lungs ventilation became unobtainable within the first hour, the thoracic ventilation in the animals without lungs remained unchanged for 22 hours, although chest muscles were in a state of rigor mortis.

A failure to obtain pulmonary ventilation in the first group of animals was caused by the post-mortem changes of the lungs.—*Peter V. Karpovich.*

Health Education

15. Crane, Marion M., Richard G. Scohie, Franklin M. Foote, and Earl L. Green. Study of procedures used for screening elementary school children for visual de-

fects: Referrals by screening procedures vs. opthalmological findings. *J. School Health*, **23**:1 (Jan. 1953).

The primary purpose of the study was to determine the relative efficiency of certain procedures used in screening elementary school age children for visual defects as measured by the success of the procedures in identifying those students whom opthalmological examination showed to be in need of eye care.

The study was conducted in St. Louis on 609 sixth-grade students and 606 first-grade students from 14 elementary schools.

There was proven to be a low degree of correspondence between the referrals by any of the screening procedures and the referrals by the opthalmologist. In general, the greater the number of correct referrals, the greater the number of incorrect referrals. Also, the greater the number of measurements involved in a procedure, the higher the proportion of both correct and incorrect referrals.—*John H. Shaw.*

16. Kilander, H. F., Fred V. Hein and Harold H. Mitchell. The accuracy of health content of school textbooks. *J. School Health*, **23**: 7 (Sept. 1953)

A total of 156 different individuals made 217 reviews of 54 public school textbooks in the field of health. Teams reviewing a book typically included a dentist, a nurse, a nutritionist or home economist, and a teacher from the general field of the book.

The number of errors in each book reported varied from 2 to 126 with an average of 43 per book or 13 errors per 100 pages. As might be expected, the number of errors increased with the age of the book. The frequency of errors was especially high in the areas of nutrition, first aid, and communicable disease.

It is recommended that textbook manuscripts be reviewed carefully for their scientific accuracy, and that health texts be revised or replaced frequently in order to keep them abreast of scientific advancements.—*John H. Shaw.*

Miscellaneous

17. Edgington, Eugene S. Kinesthetically guided movements of head and arm. *Journal of Psychology*, **36**: 51-57 (July 1953).

The study was concerned with the effect of certain factors on co-ordinated movements of the head and arms. Factors studied were the angle of the head relative to body position and angular movement of the localizing organ during localization.

Twenty subjects were tested on their ability to look where they were pointing and to point where they were looking, with vision excluded.

It was found that the subjects were significantly more variable in their ability to look where they were pointing, than in their ability to point where they were looking. In both kinds of movements it was found that the subjects underestimated the amount of movement needed.

In the arm to head movements differences in variability for different positions were not significant, while for the head to arm movements differences of variability for different positions were significant at the 5% level.—*Marjorie Phillips.*

18. Hayes, Margaret L. and Mary E. Conklin. Intergroup attitudes and experimental change. *J. of Experimental Educ.*, **22**: 1, pp. 19-36 (Sept. 1953).

A two-year project was undertaken to determine the quality and extent of changes in intergroup attitudes and the relative effectiveness of different types of teaching. First-year findings indicated that the experimental groups made more progress in the development of favorable attitudes. Girls improved more than boys toward Negro problems. New-stock Americans made the greatest gains. The Jewish-American group made the next largest gain. Intelligence was not a contributing factor. Second-year findings indicated that the instructional approach by vicarious experience was better than either the intellectual or direct experience approach.—*D. B. Van Dalen.*

Guide to Authors

IN LINE WITH the over-all goal of making Association publications yield the greatest value to the individual and the profession, the following is a guide for the preparation of research manuscripts. The information below recognizes general techniques being employed by research publications similar to the *Research Quarterly*. When copy is prepared in accordance with these instructions, all Association research studies will follow a standard style.

Manuscripts

Manuscripts should be sent to the Editor (AAHPER, 1201 Sixteenth Street, Northwest, Washington 6, D. C.), who will see that each one is read by at least three members of the *Research Quarterly* Board of Associate Editors. On the basis of the three reviews, the Editor will advise the author as to the suitability of the paper or the desirability for revision. Papers are not judged by arbitrary standards but on their content of new research results in the field of physical education, health education, and recreation, presented with the greatest brevity compatible with scientific accuracy and clarity (see October 1951 *Quarterly*, pp. 392-4).

Since three members of the Board of Associate Editors review an article, it is requested that three clear copies of the manuscript be submitted in order to facilitate reviewing. A fourth copy of the article should be retained by the author. Only one copy of any charts, photographs, drawings, graphs, or similar illustrative material need be submitted. However, since such material must be sent to each reviewer in turn, more time must be allowed for the reviews.

Typewritten manuscript should be double-spaced on white paper of ordinary weight and standard size (8½ x 11 inches).

The sheets of manuscript should be kept flat and fastened with clips which can be removed easily. The pages of the typewritten copy should be numbered consecutively in the upper right-hand corner.

Paragraphs should be numbered consecutively throughout the manuscript to facilitate ease of reference in case of revision.

Headings

The article should be arranged so as to indicate relative values of heading and subheadings.

Usually four gradations are sufficient: (a) article title, (b) first subhead appearing in boldface aligned left on page (underscored in manuscript with wavy line) (c) second subhead (if necessary) appearing in small caps aligned left on page, (d) third subhead, to appear in italic (underscored in manuscript), not centered, but run in at the beginning of the paragraph or section.

All headings should be typed in lower case with initial capitals, except for (c) above, which should be typed in capital letters.

FOOTNOTES

Footnotes are not to be used for references or literature citations. They are rather used for the purpose of acknowledgment, special explanation, supplementary information, etc. (*See examples below.*)

Type footnotes (if any) on separate sheets, as many footnotes as convenient being written on a sheet. Footnotes should be numbered from 1 up for each article; a corresponding numeral appearing in the text. Asterisks should not be used.

Examples of Footnotes:

[1] This study was made under the direction of Dr. Arthur T. Slater-Hammel in the Research Laboratories, School of Health, Physical Education, and Recreation, Indiana University, Bloomington, Indiana.

[2] All measurements of the hand were recorded in centimeters and height was recorded in inches. The hand measurements were taken by Everett and reliability coefficients of above .90 were found for each measurement used in the study.

[3] For their wholehearted co-operation in facilitating collection of the data, special gratitude is extended to Superintendent Clarence Hines and the 1950-51 principals of the Adams, Condon, Edison, Francis Willare, Harris, Howard, Lincoln, River Road, and Whiteaker schools.

Documentation

CITATIONS OF LITERATURE

Citations of literature should be segregated alphabetically by author's last name at the end of each article, under the caption of "REFERENCES." *Do not treat them as footnotes.* (*See above.*)

The literature citations, listed alphabetically, should be numbered consecutively, their location in the text being indicated by corresponding numbers written in full size and enclosed in parentheses: for example, (1) (2, 3). If there are several references in the text to a citation, the specific pages may be indicated thus: (1, *p. 117*) (1, *pp. 162-3*).

A uniform style should be maintained in writing citations. Do not enclose titles of chapters and articles in quotation marks. Italicize (underscore in manuscript) names of books and periodicals, bulletins, etc. (*See examples below.*)

Uniform sequence of data should be observed, as follows: *For a book*—Author's name (last name first); title of article or chapter; name of book; place of publication; publisher; year date. *For a periodical*—Author's name (last name first); title of article or chapter; name of periodical; volume number; inclusive page numbers; year date.

Examples of References Appearing at End of Article:

1. American Association for Health, Physical Education, and Recreation. Suggested platforms for health education. *Journal of the American Association for Health-Physical Education-Recreation* **18**:436 (Sept. 1947).
2. American Association of School Administrators. *Health in Schools.* Revised edition. Washington, D. C.: the Association, a department of the National Education Association. pp. 266-7.

3. DEAVER, G. G., Exercise and Heart Disease. *Research Quarterly*, **26**: 24-34, 1939.
4. OGDEN, JEAN, AND JESS OGDEN. *Small Communities in Action*. New York: Harper & Brothers, 1946.
5. POTTER, JOHN NICHOLAS. *Physical Fitness of Junior High School Boys*. Unpublished Master's thesis, University of California, Berkeley, 1942

Tables

Each table should have a descriptive heading and should be specifically referred to in the text by number, *e. g.*, "Table 10," etc., never as "the above table" or "the following table." Number tables from 1 up for the entire manuscript, using Arabic numerals. Do not duplicate data by giving it in *both* tables and graphs.

Tables should be double-spaced typewritten, like the rest of the material in the manscript. They should be typed on separate sheets, as the printer will set them on a different machine from the one used for the text matter. If a table continues on a second sheet, it is not necessary to repeat the boxheads, since the printer will repeat from the original boxheads, when necessary.

The word "TABLE" should be written in capital letters, as: "TABLE 1"; the table title should be written in lower case letters with initial capitals, and centered over the table. Tables should be ruled as desired, except that no rules will appear at the extreme right and left edges of the table. No double rules are to be used, unless necessary for clarity.

Illustrations

Illustrative material is of two types: pen and ink drawings, which are reproduced by the line engraving process; and photographs, wash drawings, stipple drawings (in short, anything containing shading), which are reproduced by the halftone process.

Line engravings are always treated as text figures and should be so designated. All drawings should be made with India ink, preferably on white bristol board plate, 1 ply or 2 ply, which is sufficiently transparent to permit tracing if back lighting (e.g., a window pane) is used. Avoid graph paper for the reproduction copy, as the printing interferes with proper inking and the paper permits no corrections. Sometimes it is desirable to ink in the principal guide lines so that the curves can be more easily read.

Lettering should be plain and large enough to reproduce well when the drawing is reduced to the dimensions of the printed page ($4\frac{1}{8}$ x 7 inches). Most figures can be advantageously drawn for a linear reduction of one-half or one-third. Be sure to draw the lines heavy enough so that they will not be overly thin after reduction. Explanatory lettering should be included within the chart. Typewritten lettering does not reproduce well; it is much better to use a LeRoy or similar lettering device.

Care should be taken not to waste space, as this means greater reduction and a less satisfactory illustration. Often it is possible to combine several curves in one figure and thus not only save space but enable the reader to make comparisons at a glance.

Halftones are treated as figures and should be so designated. Frequently, several halftones can be grouped to form an attractive full page, in which case they should be numbered consecutively, in Roman numerals. Photographs should be in the form of clear black-and-white prints on glossy paper. Care should be taken to see that they cannot be bent or folded in handling *and paper clips should not be used.* All imperfections in the original copy are reproduced.

Figures should each be numbered consecutively from I up for the entire manuscript. Use Roman numerals to number figures, and Arabic numerals to number tables. The legends for the illustrations should be typed upon a separate sheet placed at the end of the manuscript. Care should be taken to indicate plainly in the text the exact location of all illustrations and tables.

The Association will assume complete engraving expense.

Special Points of Style

USE OF NUMBERS

Use Arabic figures for all definite weights, measurements, percentages, and degrees of temperature (for example: 2 kgm., 1 inch, 20.5 cc., 300°C.). Spell out all indefinite and approximate periods of time (for example: over one hundred years ago, about two-and-one-half hours). For numerals used in a general sense, spell out numbers through ten and use Arabic figures for 11 and over (seven times, five years old, 11 students).

ABBREVIATIONS AND SYMBOLS

Standard abbreviations should be used whenever the weights and measurements are used with figures, i.e., 10 kg., 6.25 cc., etc. The forms to be used (for both singular and plural) are: ft., ft.-lb., ft/sec, in., yd., min., hr., sq. ft., sq. in., rpm. *Gram* should be spelled out in all cases to avoid possible confusion with *grain;* also spell out *mile.* All obscure and ambiguous abbreviations should be avoided. Symbols used should follow the notation listed in *Research Methods* (AAHPER), pp. 518-20 and 522-25. The most common are given below:

M = mean	r = Pearson correlation
Mdn = median	r_{bis} = biserial correlation
N = number of individuals	r_{11} = reliability coefficient
n = number of measurements	χ^2 = chi square
σ = standard deviation	F = variance ratio
σ_M = standard error of mean	t = Student (Fisher) t ratio

Per cent should be two words. Use per cent sign (%) in tables or when it appears in parentheses in text.

Proofreading

The author will receive his original manuscript and any engraver's proofs with the galley proofs of his article for correction. A reprint order blank will be enclosed for the author's convenience.

Corrected proofs and original manuscripts are to be returned within 48 hours by first-class mail to the Editor, AAHPER, 1201 Sixteenth Street, Northwest, Washington 6, D. C.

OTHER AAHPER PUBLICATIONS

1. **Administrative Problems in Health Education, Physical Education, and Recreation.* 1953. 136 pp. Paper $2.00; Cloth $2.50

2. ***School Health Services.* Prepared by Joint Committee on Health Problems in Education of the NEA and AMA. 1953. 480 pp. $5.00

3. *Convention proceedings of the College of Physical Education Association*—1938, '39, '40, '41, '48, '49, '51, '52, each $1.75; 1953, $2.00

4. *American Academy of Physical Education—Professional Contributions.* Papers and reports presented at the annual meetings—
   No. 1—1950—51. 94 pp. $1.50
   No. 2—1952. 88 pp. $1.50

5. *Physical Education—An Interpretation.* Third version of the Platform for Physical Education. 2-9 copies, 35c each; 10-99 copies, 25c each; 100 or more, 10c each. Single copy, 50c

6. *Desirable Athletic Competition for Children.* Joint Committee Report: AAHPER, Society of State Directors of Health, Physical Education, and Recreation, and Elementary School Principals (NEA). A guide for those concerned with athletics for children. 2-9 copies, 35c each; 10-99 copies, 25c each; 100 or more, 20c each. Single copy, 50c

7. *Recreation Bibliography.* An up-to-date list of books, with authors, publishers, dates of publication, pages, and prices. 1952. 71 pp. $1.00

8. *Annotated Recreation Bibliographies,* 1939-51, prepared by Eleanor L. Wright
   Canoeing 25c — *Sailing* 35c
   Paddle Board 10c — *Boating* 25c

9. *Evaluation Schedules for Major Programs in Health Education, Physical Education, and Recreation,* prepared as part of the American Association of Colleges for Teachers Education accreditation plan. 1952.
   A set of schedules (all 3 areas) $1.00
   Separate schedule (one area) 50c

10. ***Putting PR into HPER.* Public Relations Handbook designed especially for health educators, physical educators, and recreation personnel. Published jointly by AAHPER and the National School Public Relations Association. 1953. 68 pp. $1.00

* 10% discount on single copies to AAHPER members only. On quantity orders, NEA discount as follows: 2-9 copies, 10%; 10-99 copies, 25%; 100 or more, 33 1/3%. When NEA discount is allowed, single copy discount will not apply.
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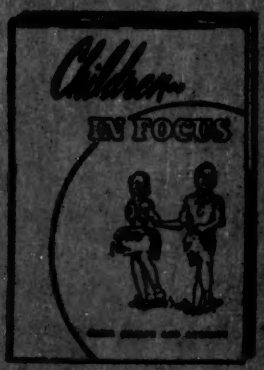

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